PB-214 469

PROBLEMS OF COMBINED SEWER FACILITIES AND OVERFLOWS: 1967

American Public Works Association
Chicago, Illinois

1 December 1967

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SELECTED WATER RESOURCES ABSTRACTS
INPUT TRANSACTION FORM

1. Report No.

3. Accession No. W 73-04566

4. Title REPORT ON PROBLEMS OF COMBINED SEWER FACILITIES AND OVERFLOWS 1967,

5. Report Date

6.

7. Author(s)

8. Performing Organization Report No.

9. Organization
American Public Works Association, Chicago, Illinois

10. Project No. FWPCA Program 1120---12/67

11. Contract/Grant No.
14-12-65

12. Sponsoring Organization

13. Type of Report and Period Covered

15. Supplementary Notes
Water Pollution Control Research Series, WP-20-11, Dec. 1, 1967. 189 p, 10 fig, 61 tab, 10 append

16. Abstract
The effects and means of correcting combined sewer overflows and separate storm and sanitary sewer discharges were inventoried ~~intentoried~~ on a national basis in 1967 and compiled. On-site personal interviews with the public officials of approximately 900 communities in the United States collected over 250,000 pieces of data which have been analysed and grouped by State, river basin, and population group to define the problems of combined sewer facilities and overflows. Nationwide projections were made for major items of interest, including area and population served by combined sewers, overflow locations, type and number of regulators, associated land and water uses, estimates of costs for sewer separation by States, alternate control and/or treatment methods, and consideration of other aspects of the overall problem. Findings, Conclusions and Recommendations are presented in summary form. (EPA abstract)

17a. Descriptors *Sewerage, *Sewage treatment, *Overflow, *Storm drains, *Alternate costs, Sewers, Sewage effluents, Sewage districts, United States, Storm runoff, Costs, Land use, Water utilization, Water pullution control

17b. Identifiers *Combined sewers,

Available from SOD-I67.13/3:11 $1.00

17c. COWRR Field & Group 05D, 05G

18. Availability
Available ~~from the National Technical Information Service~~ as ~~PB~~-214 469, ~~$3.00 in paper copy~~, $0.95 in microfiche

19. Security Class. (Report)

20. Security Class. (Page)

21. No. of Pages 19

22. Price

Send To:

WATER RESOURCES SCIENTIFIC INFORMATION CENTER
U.S. DEPARTMENT OF THE INTERIOR
WASHINGTON, D. C. 20240

Abstractor

Institution

WRSIC 102 (REV. JUNE 1971)

REPORT ON

Problems Of Combined Sewer Facilities And Overflows

1967

A National Inventory of the Effects and Means of Correcting Combined Sewer Overflows and Separate Storm and Sanitary Sewer Discharges in the United States

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
U. S. DEPARTMENT OF THE INTERIOR
by the
American Public Works Association

Contract No. 14-12-65

December 1, 1967

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ABSTRACT

The effects and means of correcting combined sewer overflows and separate storm and sanitary sewer discharges were inventoried on a national basis in 1967 and compiled in this report. On-site personal interviews with the public officials of approximately 900 communities in the United States collected over 250,000 pieces of data which have been analysed and grouped by State, river basin, and population group to define the problems of combined sewer facilities and overflows. Nationwide projections were made for major items of interest including, area and population served by combined sewers, overflow locations, type and number of regulators, associated land and water uses, estimates of costs for sewer separation by States, alternate control and/or treatment methods and consideration of other aspects of the overall problem. Findings, Conclusions and Recommendations are presented in summary form.

This report was submitted in fulfillment of Contract No. 14-12-65 between the Federal Water Pollution Control Administration and the American Public Works Association — Research Foundation.

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

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FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

A national survey of representative communities and other jurisdictional entities, served wholly or partially by combined sewer systems, was conducted by the American Public Works Association under the terms of Contract 14-12-65, designated as Project 123. The study resulted in data which throw light on the extent of the problems associated with combined sewers and overflows therefrom into the water resources of the United States; the effect of such overflows on the nation's water and land resources; the relationship of combined sewer overflows to water pollution from other waste water and drainage sources; and the methods and costs of measures to reduce or eliminate such overflows.

These data have been translated into the following Findings, Conclusions, and Recommendations.

FINDINGS

1. Approximately 200 million persons now reside in this country; about 125 million were reported to be served by combined or separate sanitary sewer systems, as of 1962. This report presents information on combined sewer service obtained by direct interviews of 641 jurisdictions having a total population of 51 million. The population of the interviewed jurisdictions directly served by combined sewers was 34 million. Projected to the entire nation, it is estimated that there are 1,329 jurisdictions, served in whole or in part by combined sewers, having a total population of 54 million. Of this projected population, it is estimated that 36 million are actually served by combined sewers. (Table II-A)

2. The area of the jurisdictions surveyed was 6,529,300 acres. Of this, 2,557,000 acres were served by combined sewers, 2,088,000 acres by separate sanitary sewers and 1,884,000 acres were unserved. The total projected area estimated to be served by combined sewers is 3,029,000 acres (Tables II-A, II-C & III-B).

3. If all jurisdictions with combined sewers were to replace them by providing a separate conduit for sanitary and industrial wastes, and another for storm water, they would face an expenditure of approximately *$30 billion.* Inclusion of the expenses incurred in making the necessary plumbing changes in and on private property to effect total separation would increase this cost to approximately *$48 billion.* However, the report strongly implies that such a calculation must be considered theoretical. Responses from many municipalities, especially those with high population densities, disclose that the possibility of changing all combined sewers to separate is remote. (Table IX-C)

4. Alternate methods of control and/or treatment other than sewer separation are in use in some jurisdictions and research is being conducted to further evaluate the effectiveness and applicability of various methods. There were insufficient data to make a detailed cost estimate of the alternate methods. However, from the limited data available, it appears that the cost of such methods would be about one-half the cost of complete separation. In addition, the expense of separating plumbing in and on private property would not be necessary. If alternate means of control and/or treatment were used exclusively, which is unlikely, the total cost would thus approximate *$15 billion.*

5. Projections resulting from the survey indicate that there are approximately 1,329 jurisdictions with combined sewer systems in the United States, instead of 2,200 previously reported to be utilizing such facilities for all or part of their populations and areas. The greatest shrinkage in numbers was found in communities of under 25,000 population, with the greatest reduction in numbers listed in the 1,000 to 5,000 population group. (Table II-A)

6. Of the 938 jurisdictions selected for the survey, 641 were found to have combined sewers and 255 were found to be utilizing no combined sewers and not to have utilized such facilities in recent years. Several jurisdictional entities not previously listed as having combined sewers were found to be utilizing such facilities and were added to the survey. (Table II-B)

7. The 641 communities and other jurisdictional entities surveyed by on-site personal interviews included all of 25,000 population and over having combined sewers, and a representative sampling of approximately 30 percent of the communities under that size believed to have combined sewers. The survey represented over 94 percent of the population and over 84 percent of the area of U. S. communities served completely or partially by combined sewers. The 280 jurisdictions with a population of more than 25,000 had combined sewer systems serving 32 million persons. In addition, approximately 2 million persons are reportedly served by combined sewers in the 331 communities surveyed with under 25,000 population. (Table II-A)

8. Jurisdictions having combined sewers are generally concentrated in three contiguous regions: (1) the Northeast (basins 1 and 2); (2) the Great Lakes (basins 6, 7 and 8); and (3) the Ohio River (basin 5). In these three geographical areas the survey covered 554 jurisdictions with 27 million population served by combined sewers. (Figure II, Table III-A)

9. In the jurisdictions surveyed, the population served by separate sanitary sewers is approximately one-half of that served by combined sewers—15,425,000 and 34,080,000, respectively. The total length of the combined sewers is 54,935 miles; 44,286 miles of separate sanitary sewers and 17,151 miles of separate storm sewers are also utilized. (Table III-A, III-H)

10. A large number of urban areas in the United States are not yet sewered. In the surveyed jurisdictions, 1,884,000 acres with a population of 1,574,000 were not sewered. The low density of less than one person per acre indicates the undeveloped or underdeveloped nature of these unsewered urban areas. (Table III-B, III-C)

11. The survey covered 30 jurisdictions serving 69 communities which render sewer service or water pollution control treatment service to communities with combined sewers. It revealed that responsibility for providing such service is often divided between sanitary districts or other jurisdictions and the communities they serve. This poses complex questions such as who is responsible for taking corrective action regarding combined sewer overflows and who will benefit from the lower operating costs of pumping stations and treatment plans when such flows have been reduced or eliminated? (Table II-E)

12. There were 19,559 full or part-time employees in 527 jurisdictions reporting. Among these employees were 798 registered professional engineers or engineers-in-training and 1,283 certified plant operators. (Table III-K)

13. Of the 641 surveyed jurisdictions, 493 reported 9,860 combined sewer overflows. In addition, 237 of the 641 jurisdictions reported 759 overflows from combined sewer pumping stations and 160 communities reported 755 separate sanitary sewage pumping station overflows. Reported treatment plant overflows or bypasses amounted to 532. In addition, 87 jurisdictions listed 2,306 "other" overflow sources. In large measure, these are unregulated discharges. The grand total of 14,212 overflows in the surveyed jurisdictions indicates the multiplicity of discharges into watercourses, lakes and coastal waters. (Table IV-A)

14. Overflows from combined sewers occur predominately at points where the land is used for industrial purposes, followed by residential, recreational, and commercial uses in that order. Treatment plant overflows occur in land areas used for industrial purposes and in vacant land areas. Pumping station overflows occur predominantly in areas where land is used for residential and industrial purposes. (Table IV-C)

15. Overflows from combined sewers represent approximately three-quarters of all overflow sources. Overflows from these sources are predominately into open drains and waters used for limited body contact recreation and fishing. (Table IV-E)

16. Of the total reported overflows, approximately two-thirds discharge into flowing streams; 5,092 utilize lakes and tidewaters as their receiving waters. (Table IV-G)

17. A total of 10,025 regulators at combined sewer overflow structures and other locations are used by the jurisdictions surveyed. The most commonly used types were reported to be perpendicular weirs, side weirs and "others," all of the non-mechanical type. The least commonly used were mechanical types such as hydraulic cylinders, manual or automatic valves, and tipping gates. (Table VI-A)

18. While water pollution from all sources has been charged frequently with the depreciation of realty values, the survey provided little evidence to prove this claim. The study revealed one specific case history on the degradation of land values in the vicinity of combined sewer overflows, and a consequent reduction in municipal tax returns in the affected area. (Appendix I)

19. The performances of all types of regulators were rated as about the same. The cost of regulator maintenance varied widely, averaging $527 per regulator per year. Twenty-two percent of the jurisdictions interviewed reported no regular inspection of their regulators. (Table VI-E)

20. Dry weather overflows from combined sewers were reported by 96 jurisdictions. The cause of the overflow was described by one-half of those reporting as the presence of troublesome regulators, and the other one-half reported insufficient sewer capacity. (Table VI-G)

21. Infiltration was reported as a problem under dry weather conditions by 14 percent of the jurisdictions surveyed; under wet weather conditions, 53 percent reported infiltration as a problem. (Table VI-G)

22. Few of the jurisdictions surveyed have monitored the quantity and quality of combined sewer overflows. A total of 61 jurisdictions reported that they had made some measurements of the quantity of their overflows and 54 indicated that some quality tests had been made. These generally were of limited duration. (Table VI-H)

23. Large amounts of industrial wastes are discharged into the sewer systems of the jurisdictions surveyed. The total industrial wastes population equivalent reported for these systems was 26,875,000. This represents the equivalent of an additional population of 69 percent of the total reported by 192 jurisdictions. (Table VII-B)

24. The study disclosed that 19 percent of the jurisdictions surveyed are not served by water pollution control plants. Approximately 53 percent of the water pollution control plants provide primary treatment; 45 percent secondary treatment; and about two percent utilize tertiary treatment methods. Twelve percent of the surveyed jurisdictions depend upon other jurisdictions of a multi-community type to treat their sanitary sewage. (Table XIII-C)

25. Bypassing of untreated or partially treated sewage occurs at water pollution control plants at frequent intervals, for various reasons, including the overtaxing of plant capacities during storm flow periods. (Table VIII-D)

26. The survey showed that the median wet-weather to dry-weather design capacity ratio for combined interceptor sewers was 4 to 1. The wet to dry-weather capacity ratios reported ranged from 1:1 to 8:1.

27. Discharges of storm water from separate storm sewers occur more frequently and for longer durations than from combined sewers because regulator devices in combined sewer systems prevent overflows during minor rainfall events. (Table IV-1)

28. The jurisdictions surveyed reported 1,775 sewer separation projects—predominately of a partial-system nature—and 546 other treatment and control installations. Other corrective measures reportedly used, planned, or considered applicable include in-system storage, off-system storage, automated regulators, disinfection, screening, sedimentation and chemical treatment. A number of communities also reported that surface drainage area control projects were effectively used to regulate the flow of storm water into the collection sewer system. (Table VII-A1)

29. Engineering studies on overflow problems have been made in 310 of the jurisdictions surveyed. Of these, 220 jurisdictions have made estimates of the cost for a project or projects to eliminate all or part of their combined sewer overflow problems. In addition, 222 jurisdictions surveyed reported current plans for sewer separation projects and 52 jurisdictions have plans for constructing alternate control or treatment facilities. (Table IX-A)

CONCLUSIONS

1. Findings of this survey confirm that combined sewer overflows constitute a significant part of the nation's total water pollution problem. It is important to recognize, however, that the overflow problem must be evaluated in terms of the total effects on water and land resources from all overflows, discharges and spills of waste waters, not as an isolated and unrelated source of water pollution.

2. Despite current concern over the problems of combined sewers and their overflows, U. S. communities continue to build combined sewers to replace and extend existing sewer systems. Active programs to eliminate or minimize the volume and strength of overflow wastes are impeded by the high cost of such projects; the inconvenience to urban life and activities; the lack of specific information on the amounts and character of these overflows and their actual impact on water and land resources; and uncertainty as to the importance of this source of pollution in relation to other pollution factors.

3. Greater concern over combined sewer overflows can be expected as other sources of pollution are abated. These include discharges of untreated or improperly treated sewage; bypasses of flows at water pollution control plants due to lack of capacity and inadequacies of processes, operation, maintenance and control; discharges of separate storm waters which carry urban debris and other pollutional components; discharges of such pollutional flows as mine drainage; and runoff from rural areas, with their natural, animal and man-contributed contaminants.

4. There is a definite need for further research to determine the quantity and quality of overflows and the relative extent and detrimental effect of all sources of pollution. Engineering studies are also needed to establish, for each locality, cost effectiveness schedules of priorities for the correction of overflows as part of overall pollution control programs and to offer workable and feasible fiscal solutions therefor.

5. The survey revealed that the jurisdictions surveyed did not have the necessary information required to evaluate the extent and effect of the combined sewer overflow problem. This is due to several factors including the lack of awareness and concern for the problem by responsible elected and administrative officials of the communities, insufficient numbers of properly trained personnel, and inadequate record systems.

6. Standards do not exist to judge the adequacy of the number of employees working on sewer and water pollution control plant functions. The nature of the jurisdiction, the amount of new construction, the degree of automation of the treatment plant, and the complexity and state of maintenance of the system as well as the extent that consulting engineers and contractors are used are factors which determine the number of employees required. However, the results of the survey indicate that many jurisdictions do not have adequate staffs.

7. The use of joint multi-community interceptors and central water pollution control plants usually offer greater economy in handling waste waters from urban areas. Typical questions which must be resolved where this practice is followed include: which entity should provide for sewer separation or other means for control and/or treatment of over-

flows; who will pay for such facilities and benefit therefrom; and how equitable service charges shall be allocated.

8. The combined sewer problem is complex and difficult to define. For example, in the case of multiple community regional operations, some of the communities which utilize joint facilities are sewered as separate systems but they discharge separate sanitary flows into combined interceptors or into combined collection sewers of older central cities. This separate sanitary sewage thus becomes combined wastes and contributes to the overflow problem "by association." This general problem also occurs frequently in communities which have both separate and combined sewers. The flow from the separate sanitary sewers enters the combined sewers, thus contributing to overflows.

9. Excessive infiltration into combined sewers usurps valuable sewer capacities and increases the frequency and duration of overflows. The survey disclosed that infiltration frequently exceeds design and code limits. Correction of excessive infiltration could reduce the overflow problem by providing increased in-system capacity for the storage of more combined sewage flows.

10. Local flooding of basements and underpasses, and overflows from surcharged manholes result from inadequate sewer capacities and occur under the same storm conditions which produce combined sewer overflows. Any action by communities to enlarge collection sewer systems in areas served by combined sewers would reduce flooding conditions; provide more in-system storage capacity; and reduce overflow incidents and durations.

11. Many regulator devices are of inadequate or uncontrollable types; are inadequately inspected and maintained; and produce unnecessary and extended overflows which increase pollution in receiving waters. Improvement in such devices, coupled with more effective maintenance, could reduce the overflow problem.

12. Increased capacity and augmentation of treatment processes could eliminate or reduce bypassing of water pollution control plants. Problems due to bypassing of high storm flows in supposedly separate sanitary sewer systems would be minimized.

13. While sewer separation has been advocated as a positive method for eliminating combined sewer overflows, and separation projects are reported to be the most commonly used corrective measure in the surveyed communities, most separation work has been carried out on only portions of sewer systems, seldom involving the entire system.

14. Sewer separation is not the panacea of all combined sewer problems. Other overflow corrective measures have merit, not only in terms of comparative cost to separation, but also in terms of cost and convenience to property owners and the general public. Other than sewer separation, surface-drainage control, storage and off-system treatment are considered to be promising methods of reducing or eliminating the pollutional effects of overflows.

15. Generalized cost estimates for the control and/or treatment of combined sewer overflows must be applied to specific cases or communities with care and caution. The needs and conditions of communities vary widely and their effects on the cost of sewer separation or other

methods for the control and/or treatment of overflows are not predictable without a thorough engineering and fiscal study.

RECOMMENDATIONS

1. There is urgent need for further research to develop new, effective and more economical means for the control and/or treatment of overflow wastes, to supplement presently known and acceptable processes, designed to meet the different conditions in the various regions and localities of the nation. Such new methods should be applicable to the control and/or treatment of discharges of separate storm waters if and when such procedures are found necessary.

It is recommended that additional research be undertaken, utilizing the interdisciplines of designers, manufacturers, and water pollution control authorities to develop new methods for control and/or treatment of combined sewer overflows.

2. The uncertainty expressed by many officials as to the applicability of known overflow corrective measures to their own local conditions and needs indicates limited consideration of this problem on their part.

It is recommended that community officials be made more aware of the importance of the overflow problem in order to overcome the inertia to corrective actions disclosed by the survey.

3. There is need for the recruitment of highly trained and experienced professional personnel, and assurance of their employment tenure, adequate income and security, to administer and operate present and future sewer systems and water pollution control facilities. Funds spent for the training of such persons will be amply repaid by better operations, reduction of overflows and improvement in treatment plant effluents.

It is recommended that increased efforts be made to recruit, train and employ competent personnel in the interest of better performance of existing and new sewage works systems.

4. Improvements in uniform record-keeping in the waste water collecting-intercepting-treatment field are a necessary adjunct to the determination of local, state and national policies on the correction of the combined sewer problem and the cost thereof.

It is recommended that improved record systems be developed and utilized by agencies responsible for the management of waste water collection and treatment facilities.

5. The study brought to light the dearth of information in communities served by combined sewers on the amount and character of overflow wastes. This lack of authentic data has been a factor in the current uncertainty over the actual effect of such overflows on the receiving waters of the nation.

It is recommended that studies be initiated to properly evaluate the effect of overflows on receiving waters.

6. Inadequate regulators, of improper type to meet combined sewer flow conditions, coupled with ineffective maintenance practices and policies, are a frequent cause of unnecessary overflows. Better guidelines for the choice of facilities and equipment for specific flow control purposes, and improved devices for such applications will pay dividends in

the form of reduced pollution conditions caused by overflows. More effective maintenance and management practices will result in better operation of existing regulator installations.

It is recommended that a thorough study be instituted on regulator facilities aimed at developing better application engineering, improved devices and more effective maintenance practices.

7. The survey showed that excessive infiltration, during both wet and dry periods, often exceeds design standards and code regulations, usurping needed combined sewer capacities and increasing the frequency and duration of overflows. Reduction in infiltration in existing sewers by means of repairs and reconstruction, and in new sewers by means of better materials, jointing and construction and inspection, offer opportunities to reduce overflows.

It is recommended that in-depth studies for alleviating excessive infiltration and relating it to overflow incidents and durations be undertaken.

8. Local flooding due to inadequate carrying capacities of combined collection sewers cause expense, inconvenience and health hazards to residents of the affected areas. The storm flows which cause these community conditions are the same ones which produce overflows in combined sewer systems. Correction of sewer system inadequacies to overcome local flooding offers opportunities to provide added sewer capacities which could be used for in-system storage of storm flows and for a resultant reduction in overflow incidents and periods of duration.

It is recommended that sewer system improvements be undertaken to overcome local flooding, and, at the same time, provide an in-system storage capability.

9. Surface drainage control projects offer a means by which the flow in sewer lines may be regulated and overflows controlled.

It is recommended that consideration be given to the use of surface drainage controls in the development of open spaces, parks, playgrounds and other urban land.

10. The numerous instances of dry-weather overflows occurring because of troublesome regulators and insufficient sewer capacity constitute a continuing source of pollution. Since such overflows are seldom monitored, it may be assumed that many more occur than were actually reported.

It is recommended that programs to monitor combined sewer overflow events be initiated and that remedial steps be taken to prevent or reduce this source of pollution as soon as practicable.

11. Any efforts to reduce combined sewer overflows would be ineffective without concurrent action to provide adequate treatment of waste water discharged into receiving streams.

It is recommended that high priority be given to the construction of treatment plants in communities not presently served by such facilities and that steps be taken to upgrade the level of treatment provided where this is warranted.

12. The large amount of water pollution control plant bypassing which has been reported constitutes an important source of pollution.

It is recommended that treatment plant additions or modifications be *undertaken which would allow at least partial treatment of flow now being bypassed.*

13. The trend toward metropolitan growth in urban complexes is expected to increase the need for, and the number of, multi-jurisdictional agencies rendering joint services for the collection, interception and treatment of waste water flows. More information is needed on the characteristics of joint systems, such as those under the jurisdiction of sanitary districts; their locations, the extent of service and the governmental and financial arrangements under which they function, the split responsibility between them and their constituent communities; and the means by which they can provide and pay for combined sewer overflow solutions of various types.

It is recommended that a full-scale study be made of the powers, responsibilities and other factors involved in multi-community service agencies, to augment the information gained during the course of this study.

GLOSSARY OF TERMS
USED IN THE REPORT

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Automated Regulator System—A system which actuates a regulator device from an outside source, determines the amount of flow introduced from a collection sewer system into an interceptor, transmits information on flow or other conditions back to a central control location, and corrects or adjusts the regulator device to conform with a predetermined operational program.

Bypass—A structural arrangement of pipes or conduits, with or without gates or valves, which permits flows of sewage or other wastes to be diverted around and away from any hydraulic facility and discharged at another point such as a stream, lake or coastal water area.

Cellar Drain—A pipe or drain line which collects and removes waters from a basement or substructure of a building, or which intercepts such waters before they enter a structure, and transmit it to a point of discharge such as a public sewer system (synonymous with a foundation drain).

Collection Sewer—A pipe or conduit which collects sewage or other waste-water from their points of origin and conveys these flows by means of other connecting sewers to points of treatment or discharge.

Combined Sewer—A sewer which carries sanitary sewage with its component commercial and industrial wastes at all times, and which during storm or thaw periods serves as the collector and transporter of storm water from streets or other sources, thus serving a "combined" purpose; combined sewers make provision for the overflow of excess amounts of flow from the combined system to points of discharge.

Complete Sewer Separation—Facilities for the separation of all public combined sewers into two separate and independent sewer systems, one for the handling of sanitary sewage and industrial and commercial wastes, and the other for the handling of storm water flows; this term does **not** include any separation of sanitary flows from drains for handling cellar drainage, roof leaders or other so-called clean waters on or in private property.

Control Device—An apparatus, device or structural configuration which controls or regulates the amount of sewage and storm water flow admitted to the interceptor sewer system from a collection sewer in which it is installed, and then permits the remainder of the total flow in the collection system to be discharged into receiving waters by means of overflow facilities (synonymous with Regulator Device).

Dilution Factor—The ratio between the volume of flow in a receiving stream or watercourse at the point of discharge or overflow of waste waters, and the volume of the waste waters so discharged; a dilution factor of 25 to 1 means that the receiving stream flow is 25 times as great as the volume of sewage and storm water discharged into the stream.

Discharges—Any flows into receiving waters from sewer lines, such as those from combined sewers or from separate storm sewers or sewers carrying sanitary flows which are not connected to sewage treatment facilities; (discharges are distinguished from overflows which are regulated by devices that control the amount of flows entering an interceptor sewer).

Drainage Basins—A geographical area or region which is so sloped and contoured that surface runoff from streams and other natural watercourses is carried away by a single drainage system by gravity to a common outlet or outlets; also referred to as a Watershed or Drainage Area.

Frequency of Storm (Design Storm Frequency)—The anticipated period, in years, which will elapse, based on average probability of storms in the design region, before a storm of given intensity and/or total volume will recur; thus, a 10 year storm can be expected to occur, on the average, once every 10 years and sewers designed to handle flows which occur under such storm conditions would be expected to be surcharged by any storms of greater amount or intensity.

Industrial Wastes—Waste waters discharged from wet-processing industries after being used in various phases of production, and containing substances or materials in suspension or solution, or in colloidal form, associated with such industrial operations.

Industrial Wastes Population Equivalent—The estimated number of persons who would contribute, in the form of sanitary sewage wastes with the same amount of biological oxygen demand (B.O.D.) per day which industrial wastes carry into the public sewer system. (The estimates reported in this study were, in most cases, calculated on the basis that the average person contributes 0.167 pound of 5-day B.O.D. organic matter to the sewer system each day.

Infiltration—Ground water which leaks or seeps into a sewer through defective joints, ruptured or porous pipes or manholes, or other sewer system appurtenances.

In-System Storage—Facilities or the capacity for holding or retaining of flows of sewage and other wastes in subterranean storage chambers or other portions of the sewer system in order to minimize overflows from combined sewers and permit the treatment of large volumes of such flows.

Interceptor Sewer—A sewer which receives dry-weather flows from a combined collection sewer system, and predetermined additional amounts of storm flow, by means of any form of regulating device, and then conducts these flows to point of treatment or discharge. The flow not intended to be so conducted then overflows to receiving waters.

Limited Body Contact Recreation—Use of natural waters, such as rivers, lakes and coastal waters, for recreational purposes which do not represent deliberate or planned total body immersion such as swimming or bathing; thus, use of waters for boating, fishing and related sports.

Off-System Storage—Facilities for holding or retaining excess flows from combined sewers, over and above the carrying capacity of the interceptor sewers, in chambers, tanks, lagoons, ponds or other basins which are not a part of the subsurface sewer system.

Overflow—The excess flow from combined sewers which is not conveyed to the plant for treatment, but transmitted by pipe or other channel directly to the receiving waters.

Partial Sewer Separation—The physical separation of existing combined sewers into two separate facilities—one for sanitary sewage and industrial wastes and the other for storm water—for only a portion of the public sewer system; partial separation is, thus, only part of the complete program to separate an entire community combined sewer system.

Population Density—The mathematical figure which represents the average number of persons residing on an acre of land; the number of persons per acre of area.

Population Served by Combined Sewers—The number of persons in a community whose sanitary sewage is discharged into combined sewers; the population served by combined sewers is not necessarily the total population of a community. In cases where a community has both combined and separate sewers, the population served by combined sewers is the actual number of persons residing in structures connected directly to such sewer facilities, **not** the total community population.

Potable Water—Natural waters, which after treatment, are intended for drinking purposes by humans.

Primary Treatment—Processes or methods that serve as the first-stage treatment of sewage and other wastes, intended for the removal of suspended and settleable solids by gravity sedimentation; provides no changes in dissolved and colloidal matter in the sewage or wastes flows.

Roof Leader—A drain or pipe that conducts storm water from the roof of a structure, downward and thence into a sewer for removal from the property, or onto or into the ground for runoff or seepage.

Sanitary District—A service entity or agency, created by a governmental unit or units to provide and operate facilities for the collection, interception and treatment of sanitary sewage, industrial wastes and storm water, or any part of such services, for constituent or contributing communities. (Note: This term is used in this report to represent any multi-municipality agency which renders such services under any type of administrative or fiscal arrangements with the communities served.)

Sanitary Sewage—Waste water discharged from homes, commercial establishments and other structures, designated as "sanitary" flow because it is composed of used or spent water resulting from human use in so-called sanitary conveniences.

Secondary Treatment—Processes or methods for the supplemental treatment of sewage and other wastes, usually following primary treatment, to effect additional improvement in the quality of the treated wastes by biological means of various types, including activated sludge treatment or trickling filter treatment, designed to remove or modify organic matter.

Separate Sanitary Sewer—A sewer which carries sewage flows from homes, commercial establishments and other structures, and certain types of industrial wastes, but from which the flow of storm water is barred. (Note: Sanitary sewers carry normal amounts of infiltration flows.)

Separate Storm Sewer—A sewer which carries storm water from street runoff and other drainage areas, but not sanitary sewage or industrial wastes.

Sewage Pumping Station—An installation that pumps or lifts sewage and other wastes from a lower level in a sewer system into a higher sewer or a receiving chamber for transportation to a treatment plant or point of discharge.

Storm Water—Waste water which results from precipitation, such as rain and snow, and runs off or drains away during and after such precipitation.

Tertiary Treatment—A third stage of treatment of sewage and other wastes, following primary and secondary treatment, for the purpose of further improving the quality of the treated waters by the removal or modification of constituents which have not been removed or modified by previous treatment stages.

Total Sewer Separation—Facilities for the separation of all public combined sewers into separate and independent systems for the handling of sanitary and industrial wastes flows and storm water flows, and the separation of sanitary flows from drainage water flows in and on private property. This term means the **total** separation of **all** sanitary flows from **all** storm flows in a community.

Water Pollution Control Plant—A facility which provides processes and methods for removing or altering objectionable or pollutional constituents in sewage or other wastes to produce an effluent which is less offensive and dangerous so it can be more safely discharged into receiving waters.

Wet-Weather to Dry-Weather Capacity Ratio—An "indicator" of the capacity of an interceptor sewer, as designed, to carry the higher flows resulting from periods of storm, compared to the capacity provided by design, to handle flows during dry weather. In an interceptor sewer the additional wet-weather flow capacity makes it possible for the sewer to carry a predetermined amount of storm water, admixed with sanitary flows, to the point of ultimate treatment or disposal. Excess storm water is permitted to flow directly into receiving waters at overflow points in the collection sewer system.

SECTION I

THE OVERFLOW PROBLEM IN THE UNITED STATES

- Definition of the problem
- Historical background
- Impact of infiltration

SECTION I

THE OVERFLOW PROBLEM

The use of combined sewers in the United States and the pollutional effects of overflows from such sewers is directly interwoven with the growth and development of urban areas. The type of sewers and sewage treatment facilities which urban centers install during the coming years of growth and how they are operated and maintained will, to a large extent, determine how effectively America will protect its vital water resources against the ravages of pollution.

Successful urban living is dependent on the ability of people to receive the water they need for all of their functions by means of a public supply system. Similarly, the health, safety and comfort of persons living in urban areas is dependent on the prompt removal of man's waste waters from his immediate environment. Without these two utility services all prospects for future urban growth would be without point or purpose.

The removal of community waste waters of all types—sanitary sewage, industrial wastes and storm water—must be performed without incident. How it is done and by what methods of collection, transportation and disposal, has been until recently of only limited interest to the public. The measure of efficiency of municipal service to the average urbanite has been that removal be accomplished, not how it is done.

The nature and extent of the combined sewer overflow problem must be clearly defined if sound programs are to be developed to eliminate this source of water pollution. A basic point that must be remembered in any consideration of this problem is this: combined sewers, those carrying storm water as well as sanitary sewage and industrial wastes, are expected to overflow and are designed to provide for such overflows.

At one time sanitary engineers and public health officials felt that such overflows were sufficiently small and diluted that they posed no water pollution problem. This was probably true at the time. But under today's conditions of urban growth, the burgeoning of impervious areas and increases in runoff volumes and rates, these overflows have increased in frequency and duration and pose threats to the nation's water resources.

Storm water and sanitary sewage flowing in combined sewers also can flood the basements of homes, business and industries, as well as other critical structures within the city itself. This occurs when such sewers are surcharged beyond their capacity during periods of rainfall or thawing. This can cause inconvenience, property damage, and health and sanitation dangers. The survey explored the extent of these flooding conditions and their causes.

Historical Background

The earliest sewers in the United States followed European practices; they were intended for the collection, transportation and disposal of storm waters—with disposal into the nearest convenient watercourse at the lowest cost. The handling of so-called house sewage, as well as waterborne wastes from commercial and industrial establishments, was viewed as an individual responsibility, stemming from the days of the dry-disposal backhouse and the water-borne cesspool system. The discharge of such sanitary wastes into storm sewers was generally banned.

During this early period, combined sewers were not built because the conduits were, in fact and in practice, separate storm sewers. While these sewers were built in the early centers of population, they were duplicated, either as separate storm drains or as the recipients of sanitary flows, in communities of later establishment. This is not surprising because the tendency to "follow the leader" existed in new communities in terms of sewer practices as it did in such municipal functions as street layout and other public utilities and services.

When authorities lifted the ban on the discharge of house sewage into public sewers, the large storm drains were there and they automatically became "combined" sewers. Over and above these conversions from storm to combined sewers in older communities—simply because the existing conduits were available—specifically designed combined sewers were built in later years because they represented a lower investment cost than the construction of separate sewers for storm water, and other separate sewers for sanitary, commercial and industrial wastes.

The use of separate sanitary and storm sewers was advocated and adopted by communities when officials became concerned about pollution damage to receiving waters. They reasoned that the most practical way to correct it was to convey those liquid wastes containing the most damaging pollution in one conduit leading to a treatment works, and to discharge the storm water, which was basically rainfall runoff, directly to the most convenient body of water.

But the problem of pollution contributed by wastewater from combined sewers still remained. Engineers attacked it by designing treatment works capable of handling the dry-weather flow, plus a predetermined increase in flow volume during storm periods. Overflow structures were then provided at points in the sewer system, at water pollution control plants and at pumping stations so that any volume of water greater than the dry-weather flow plus that from storms of relatively small intensity and duration would overflow directly to the receiving stream. This was considered to be a sound procedure since the storm water causing the overflow would tend to dilute the sanitary sewage in the combined sewer and be further diluted by the increased flow in the receiving stream, thus minimizing the risk of pollution. In addition, it was felt that the most serious pollution problems resulted from overflows caused by small storms since there was less dilution in receiving streams at such times. It was reasoned that providing increased capacity to handle the smaller storms would thus reduce pollution by a significant extent at a reasonable increase in cost.

Unfortunately, only limited factual studies of the amount and character of overflows have been carried out. However, several generalizations were made in "A Preliminary Appraisal, Pollution Effects of Stormwater and Overflows from Combined Sewer Systems" prepared by the U. S. Public Health Service. These include:

(1) The annual average combined sewer overflow volumes may represent some five percent of the total pollutional discharges into the nation's watercourses;

(2) The average overflow from a combined sewer may contain from three to five percent raw sewage; and

(3) During storm peaks, as much as 95 percent of the sanitary sewage in the sewer may overflow directly to the receiving stream.

It is also important to note that storm water, even when separated from sanitary sewage, contains polluting material that may affect the quality of receiving waters. Rain water flowing down city streets, for example, is far from pure.

Combined sewer overflows are only one of many sources of water pollution. Water quality is degraded by sewage and industrial waste discharged without treatment, and from plants that do an inadequate job of removing the pollutants. In addition, there are other important sources of pollution such as:

- spills from sanitary sewers subject to flows greater than their design capacities;
- discharges from so-called separate sanitary sewers provided with relief by-pass facilities to prevent surcharging caused by storm water entry;
- bypasses at pumping stations or treatment plants;
- overflows resulting from malfunctions or improper operation and maintenance practices, such as failure to utilize the maximum capacity of the interceptor;
- discharges from surface runoff from rural and agricultural areas, often carrying troublesome pollution.

Interceptor sewers in combined sewer systems play a significant role in the problem. In the past, when communities installed a combined sewer system, without any treatment facilities, the collected liquid wastes were discharged at numerous outfall points. However, when the need for treatment arose, engineers designed sewers that would "intercept" the waste flow and convey it to the treatment plant. These interceptors were designed to receive the dry-weather flow, plus a predetermined increase in flow during periods of storm water runoff. Some type of overflow regulator was provided at each point where the combined sewer connected to the interceptor sewer. The interceptor design ratio of wet weather to dry-weather flow may vary from 1½:1 to as high as 5:1 or greater. Sewers designed with a higher ratio are larger and thus reduce the frequency and number of overflow events since they are able to convey larger volumes of flow to the treatment plant.

Impact of Infiltration

Infiltration water in combined sewers, as in separate sanitary sewers, is expected; it is difficult to prevent. While engineers anticipate such flows in sewer system design, they use design carrying capacities and, in excessive amounts, add to the frequency and duration of overflows and to the loading on sewage treatment processes. Because of this, the question of infiltration rates and effects under both dry-weather and wet-weather conditions were explored in the national inventory questionnaire used in gathering data in the course of the survey.

Infiltration is not inflow; it does not include water entry via actual sewer connections such as roof and foundation drains or inflow through manhole covers. It does cover leakage into sewers through defective sewer sections, house laterals, joints, manholes and other sewer appurtenances. This points up the fact that reduction of infiltration by better sewer design and construction methods, better jointing practices and other attempts to create "bottle-tight" sewers in modern design would result in fewer overflows of lesser duration to receiving waters.

Infiltration may occur in wet or dry weather. It does not result solely from precipitation. Its source is ground water; and the water table may be above the sewerlines during both wet and dry periods. It is obvious, however, that the ground water table will fluctuate with precipitation, irrigation or thaw conditions and that prolonged wet-weather or related conditions can raise ground water levels and induce greater infiltration into submerged sewer lines. In low ground water table areas, exfiltration from defective sewers may be changed to infiltration if the ground water table rises and inundates the sewer lines.

In general, the infiltrated water is "clean water"—usually free from organic polluting material. However, it occupies space in the sewer that should be used by the wastewater. The result of excessive infiltration is increased flow in combined sewer lines and greater frequency and duration of overflows into receiving waters from surcharged systems.

Improved pipe, water-tight joints and better sewer laying and inspection practices are resulting in marked decreases in infiltration. The problem of reducing infiltration in existing sewers remains even though substantial progress has been made in eliminating excessive infiltration in new construction. However, points of heavy infiltration can now be located by such means as closed-circuit television inspections and new improved methods have been developed for sealing leaks.

Various questions, such as those listed below, serve to illustrate the nature and ramifications of the combined sewer problem.

- At how many points in the sewer system is the admixture of sewage and storm-water expected to overflow?
- What other overflows, if any, occur?
- What are the impacts of overflows and discharges on the water resources and the abutting land?
- How often do rainfalls occur of such duration and intensity that sewers cannot carry away runoff and flooding of basements and other areas occur?
- What types of regulator devices control the amounts of sewage diverted to interceptors and to what extent are they effective?
- Have overflow wastes been monitored for total volume and quality?

Data collected in conducting this study provide answers to these and other related questions concerning the pollution caused by the overflow of combined sewers. Of equal, if not of greater, importance is the information developed and presented in this report on ways and means of reducing this source of pollution and their relative costs.

SECTION II

BASIC SURVEY DATA FOR SELECTED COMMUNITIES

Questions Covered by the Survey

Basis of selection of communities—city; county; state; drainage basin

Population served; population groupings; population densities

Water basins, in terms of population groupings

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SECTION II

BASIC SURVEY DATA

On-site personal interviews with public officials provided the bulk of the data in this report. The information is detailed, was collected by men knowledgeable in the field of sanitary engineering and public works, and is supported by engineering reports on combined and other types of sewer projects and problems in many surveyed communities.

The information as received from the interviewers on the questionnaires, copies of which are included in this report as Appendices A and B, was edited in the manner indicated in Appendix D. Through the use of electronic data processing equipment, all information was grouped by population ranges. The data were then presented in summary form in national, state and drainage basin tables, the first two of which appear as Appendices E and F. Throughout the text of this report information is presented by drainage basins.

Figure I, located on the last page of this report, shows the areas designated as major drainage basins of the United States utilized in evaluating and reporting the survey data.

Projections were made for the entire nation for major items of interest. These were accomplished by determining what percentage of the jurisdictions in each group surveyed under 25,000 population had combined sewers. These percentages were then multiplied by the number of communities in each population group thought to have combined sewers as indicated on the list supplied to the APWA by the FWPCA, and subsequently corrected by the findings of the survey.

Table II-A contains statistics that show the basic survey data in the context of the nation as a whole. In it are listed, by population groups:

(1) The 19,780 communities, the 125,770,000 population sewered and the 115,770,000 acres of all communities in the United States

(2) The 611 communities surveyed (exclusive of the multi-community service jurisdictions) which were found to be using combined sewers for all or part of their sewer system, and the 34,080,000 population and 2,557,000 acres which in these communities were actually served by combined sewers

(3) The projected number of 1,329 communities served in whole or part by combined sewer systems, and the projected population of 36,236,000 and 3,029,000 acres directly served by combined sewers.

From the national projections it is estimated that 46 percent of the communities using combined sewers were surveyed. However, the communities surveyed have 94 percent of the total population directly served by combined sewers and 84 percent of the area so served. Of the total sewered population in the United States, 29 percent is estimated to be served by combined systems. The surveyed area served by combined sewer systems is 2,557,000 acres or only 2.2 percent of the sewered area of all communities in the nation.

Figure II is a graphic presentation of the total population; sewered population; and projected population served by combined sewers by population groups. For communities of over 100,000, the sewered popula-

TABLE II-A—TOTAL NUMBER, POPULATION AND AREA OF U. S. COMMUNITIES (PLACES) COMPARED TO THOSE SERVED BY COMBINED SEWERS[1]

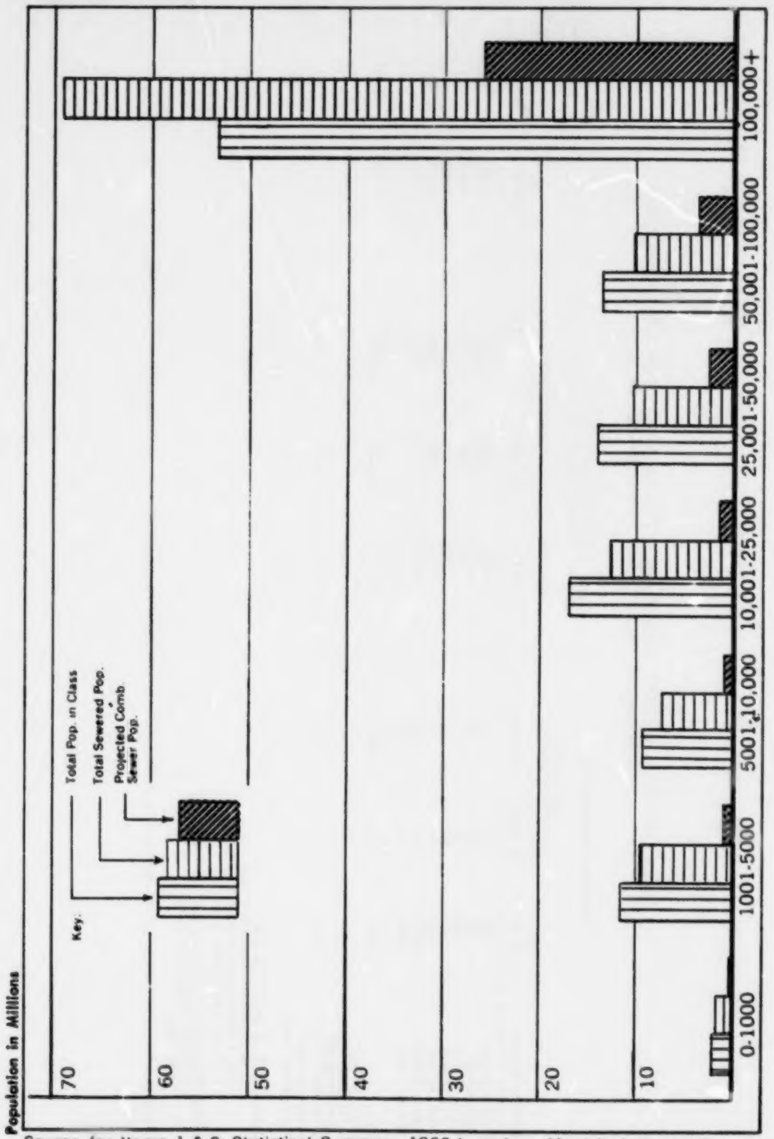
Population Groups	Number of Communities			Population (in 1,000's) of Communities Served by			Area of Communities		
		Served by Combined Sewers		Sewers[2] in U. S.	Combined Sewers			Served by Combined Sewers (1,000 Acres)	
	In U. S.	Surveyed	Projected		Surveyed	Projected	In U. S.	Surveyed	Projected
100,001 and over	132	75	75	51,013	26,261	26,261	5,300	1,423	1,423
50,001-100,000	201	86	86	13,836	3,854	3,854	2,260	472	472
25,001- 50,000	432	119	119	14,951	2,385	2,385	3,400	313	313
10,001- 25,000	1,134	97	203	17,568	895	1,865	4,450	164	337
5,001- 10,000	1,394	96	227	9,780	423	911	3,230	112	214
1,001- 5,000	6,613	124	458	14,590	253	874	97,130	69	235
Less than 1,000	9,874	14	161	4,032	9	86	—	4	35
Total	19,780	611[3]	1,329	125,770	34,080	36,236	115,770	2,557	3,029
Percent Surveyed to National Total	—	3.1	—	—	27	—	—	2.2	—
Percent Projected to National Total	—	—	6.7	—	—	29	—	—	2.6
Percent Surveyed to Projected Total	—	46	—	—	94	—	—	84	—

[1] Source: U. S. Bureau of Census
U. S. Census of Population 1960
Vol. 1 Characteristics of the Population
Part 1 United States Summary

[2] Source: Statistical Summary of the 1962 Inventory
Municipal Waste Facilities
PHS 1065

[3] This does not include the 30 sanitary districts and similar jurisdictions that were surveyed which provide combined sewer service.

FIG. II. COMPARISON OF TOTAL POPULATION, SEWERED POPULATION, AND PROJECTED COMBINED SEWER POPULATION, BY POPULATION GROUP.



Source for Items 1 & 2: Statistical Summary 1962 Inventory, Municipal Wastes Facilities in the United States.

tion served exceeds the total population since jurisdictions of this size often provide sewer service for adjacent, smaller communities.

Table II-B shows how the jurisdictions were selected for the survey. An FWPCA revised statistical summary prepared from the 1962 Inventory—Municipal Waste Facilities—PHS 1065, listed 2222 jurisdictions believed to be served by combined sewers. Approximately 900 of these jurisdictions were to be selected for on-site interviews. APWA contacted a total of 938 jurisdictions. More communities were contacted than was required, since many sewer systems were found to be interconnected. Of those selected for survey, some no longer exist, some provided no pertinent data, some had no public sewer systems and some had no combined sewers. This left a total of 641 surveyed jurisdictions with completed reports providing meaningful information. Of the 641 jurisdictions, 30 were sanitary districts or similar entities, leaving a total of 611 communities. All of the urban communities with populations of more than 25,000 were included. Of the communities smaller than 25,000, the survey covered 30 percent of those in each state, unless the state had fewer than ten. In these cases, the survey covered all the municipalities with populations greater than 2,000.

The investigators surveyed some jurisdictions not included on the original list. On-site visits disclosed that it was essential to include them because they are a part of a regional multi-community sewer system involving joint service for the collection, interception or treatment of waste water flows. This is one of the indications of the trend of urban governments toward solving their sewage problems on a regional basis where this is practical.

Table II-C shows the number of jurisdictions surveyed, their population, area and density, by drainage basins. The percentage distribution of these data is presented in the table, which also reveals that the population of the 641 jurisdictions surveyed totaled 51,079,000; their area totaled 6,529,300 acres and the population density of the surveyed communities was 7.8 persons per acre. The population densities were above the overall average for only four of the 16 basins.

TABLE II-C—NUMBER, POPULATION, AREA AND DENSITY OF JURISDICTIONS SURVEYED BY DRAINAGE BASIN

Drainage Basin No.	No. of Returns[1]	%	Population x 1,000	%	Land Area (1,000 Acre)	%	Population Density (Pop./Acre)
1	128	20	14,760.5	29	1,626.4	25	9.1
2	57	9	5,543.5	11	378.1	6	14.7
3	9	1	1,129.0	2	182.1	3	6.2
4	3	—	144.5	—	25.3	—	5.8
5	142	22	5,875.1	12	1,094.0	17	5.4
6	34	5	2,201.5	3	345.4	5	6.4
7	99	15	6,957.2	14	751.9	12	9.3
8	94	15	6,100.0	12	808.8	13	7.5
9	23	4	3,622.3	7	602.9	9	6.0
10	3	—	210.5	—	55.8	1	3.9
11	2	—	25.8	—	6.9	—	3.7
12	3	—	1,218.2	3	223.8	3	5.5
13	33	5	1,698.9	4	276.5	4	6.1
14	4	1	1,400.7	3	121.6	2	11.5
15	3	—	124.0	—	17.3	—	7.3
16	4	1	67.3	—	12.5	—	5.6
Total	641	98[2]	51,079.0	100	6,529.3	100	7.8

[1] Includes returns from 30 sanitary districts and authorities serving, in whole or in part, one or more of the communities surveyed. The distribution of these jurisdictions is shown in Table II-E.

[2] The remaining 2% is represented by fractional percentages in Basins with very few returns.

TABLE II-B—ANALYSIS OF JURISDICTIONS SELECTED AND INTERVIEWED BY POPULATION GROUP

	Number of Jurisdictions									
	National[1] Inventory	Selected	Consolidated or not Existing	No Respondent or Significant Data	NET	No Public System	No Comb. Sewer System	Completed Reports	Over-lapping Districts	Projected Number of Communities With Combined Sewers
0-500	125	7	0	0	7	1	4	2	—	50
501-1,000	253	29	0	2	27	2	13	12	—	111
1,001-5,000	927	258	2	9	247	10	113	124	—	458
5,001-10,000	321	147	2	3	142	0	45	97	(1)	227
10,001-25,000	290	149	4	2	143	1	44	98	(1)	203
25,001-50,000	144	141[2]	2	0	139	0	19	120	(1)	119
50,001-100,000	80	102	1	0	101	0	10	91	(5)	86
100,001-500,000	60	76	0	0	76	0	7	69	(14)	55
500,001+	22	29	1	0	28	0	0	28	(8)	20
	2,222	938	12	16	910	14	255	641	(30)	1,329
Sanitary Districts and overlapping jurisdictions	42									
Total Jurisdictions	2,264									

NOTE: [1] Includes all jurisdictions reported by FWPCA on original assignment printout and those added during the course of the survey.

[2] Number selected and number reported in the population groups above 25,000 would normally be identical since all jurisdictions above this figure were selected and interviewed, but changes in reported population, the distribution of overlapping districts to these population groups, and the separation of some communities into more than one jurisdiction, account for the noted differences.

Tables II-D, II-F, and II-G classify the number, total population and area of the surveyed jurisdictions by basins, and population groupings. It is significant that basins 1, 2, and 5 through 9—generally the north central and northeastern portion of the nation—account for 90 percent (549) of the jurisdictions; 94 percent (45,058,000) of the population; and 86 percent (5,604,000 acres) of the area surveyed.

TABLE II-D—DISTRIBUTION OF NUMBER OF COMMUNITIES SURVEYED BY POPULATION GROUP AND DRAINAGE BASIN
(Does Not Include Overlapping Sanitary Districts or Authorities)

Drainage Basin No.	0-500	501-1,000	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
1	1	3	22	16	16	29	17	16	3	123
2	—	1	16	11	8	4	8	5	3	56
3	—	—	—	—	2	1	2	3	1	9
4	—	—	1	—	1	—	—	1	—	3
5	1	7	36	23	27	24	13	5	3	139
6	—	1	5	7	7	4	4	5	1	34
7	—	—	17	14	13	26	13	3	2	88
8	—	—	14	10	10	23	18	9	2	86
9	—	—	6	5	2	1	3	3	3	23
10	—	—	—	—	—	—	3	—	—	3
11	—	—	1	—	1	—	—	—	—	2
12	—	—	—	—	—	—	1	1	1	3
13	—	—	4	8	10	6	2	2	—	32
14	—	—	—	—	—	—	—	2	1	3
15	—	—	—	1	—	1	1	—	—	3
16	—	—	2	1	—	—	1	—	—	4
Total	2	12	124	96	97	119	86	55	20	611
% of Total	0	2	20	16	16	20	14	9	3	100

Other data contained in Tables II-D, II-F, and II-G are pertinent. For instance, drainage basins 1 and 5 include almost 43 percent of the communities, total population and total area surveyed. While only 3 percent (20) of the communities were over 500,000 population, they contained 52.5 percent (26,780,200) of the population and 25.6 percent (1,677,600 acres) of the total area of the jurisdictions surveyed.

TABLE II-E—DISTRIBUTION OF NUMBER OF SURVEYED SANITARY DISTRICTS OR AUTHORITIES (WITH OVERLAPPING AREA OR POPULATION) BY POPULATION GROUP AND DRAINAGE BASIN

Drainage Basin No.	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
1	—	—	—	1	2	2	5
2	—	—	—	—	1	—	1
3	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—
5	—	—	—	1	1	1	3
6	—	—	—	—	—	—	—
7	1	—	1	3	4	2	11
8	—	1	—	—	6	1	8
9	—	—	—	—	—	—	—
10	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—
13	—	—	—	—	—	1	1
14	—	—	—	—	—	1	1
15	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—
Total	1	1	1	5	14	8	30
% of Total	3	3	3	17	47	27	100

Table II-E locates the sanitary districts or authorities that provide service on a regional basis by population groups and drainage basins. The table indicates that most sanitary districts and overlapping authorities are in drainage basins 7, 8 and 1. The number found in these basins were 11, 8 and 5 respectively. These sanitary districts and authorities serve large numbers of persons. Fourteen, for example, serve populations ranging from 100,001-500,000 and eight provide service to populations in excess of 500,001.

TABLE II-F—DISTRIBUTION OF TOTAL POPULATION OF COMMUNITIES SURVEYED BY POPULATION GROUP AND DRAINAGE BASIN[1]

(Population in 1,000's)

Drainage Basin No.	0-500	501-1,000	1,001-5,000	5,001-10,000	10,000-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
1	0.5	3.9	72.0	119.8	281.3	1,044.9	1,328.3	2,957.1	8,922.7	14,760.5
2	—	0.6	54.0	77.3	106.9	159.5	550.2	677.0	3,918.0	5,543.5
3	—	—	—	—	42.0	25.6	152.0	401.0	508.4	1,129.0
4	—	—	2.9	—	10.9	—	—	130.7	—	144.5
5	0.2	6.4	113.6	180.0	450.0	823.9	891.0	1,676.0	1,734.0	5,875.1
6	—	0.9	17.5	50.6	99.5	182.0	259.1	715.9	876.0	2,201.5
7	—	—	50.5	103.2	217.1	1,010.0	930.4	1,146.0	3,500.0	6,957.2
8	—	—	42.3	75.4	153.8	857.9	1,328.9	1,237.6	2,404.1	6,100.0
9	—	—	13.8	40.0	28.0	39.1	224.0	685.4	2,592.0	3,622.3
10	—	—	—	—	—	—	210.5	—	—	210.5
11	—	—	2.8	—	23.0	—	—	—	—	25.8
12	—	—	—	—	—	—	71.0	146.2	1,001.0	1,218.2
13	—	—	17.6	57.9	150.2	203.2	126.1	569.9	574.0	1,698.9
14	—	—	—	—	—	—	—	650.7	750.0	1,400.7
15	—	—	—	10.0	—	30.0	84.0	—	—	124.0
16	—	—	6.3	8.0	—	—	53.0	—	—	67.3
Total	0.7	11.8	393.3	722.2	1,562.7	4,376.1	6,208.5	11,023.5	26,780.2	51,079.0
% of Total	—	—	0.8	1.4	3.1	8.5	12.1	21.6	52.5	100.0

NOTE: [1] Adjusted for population of 33 communities reporting only total population.

TABLE II-G—DISTRIBUTION OF AREA OF COMMUNITIES SURVEYED BY POPULATION GROUP AND DRAINAGE BASIN

(Area in 1,000 Acres)

Drainage Basin No.	0-500	501-1,000	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
1	—	1.7	103.4	212.1	194.6	457.3	183.6	233.3	240.4	1,626.4
2	—	0.5	14.7	22.8	19.4	14.7	57.3	67.4	181.3	378.1
3	—	—	—	—	7.1	1.8	36.5	54.5	82.2	182.1
4	—	—	—	—	1.3	—	—	24.0	—	25.3
5	—	3.4	19.0	29.8	97.4	130.5	155.4	486.8	171.7	1,094.0
6	—	0.6	4.9	23.5	20.4	23.4	101.6	123.0	48.0	345.4
7	—		19.5	21.7	37.8	198.8	182.6	146.2	145.3	751.9
8	—		21.5	23.9	55.4	169.8	197.6	189.8	150.8	808.8
9	—	—	3.8	9.8	5.3	9.4	64.3	98.5	411.8	602.9
10	—	—	—	—	—	—	55.8	—	—	55.8
11	—	—	0.8	—	6.1	—	—	—	—	6.9
12	—	—	—	—	—	—	11.5	45.9	166.4	223.8
13	—	—	7.3	16.8	38.2	42.4	34.1	86.0	51.7	276.5
14	—	—	—	—	—	—	—	93.6	28.0	121.6
15	—	—	—	2.4	—	2.9	12.0	—	—	17.3
16	—	—	1.1	1.7	—	—	9.7	—	—	12.5
Total	0	6.2	196.0	364.5	483.0	1,051.0	1,102.0	1,649.0	1,677.6	6,529.3
% of Total		0.1	3.0	5.6	7.4	16.1	17.0	25.2	25.6	100.0

The distribution pattern of the survey data was predetermined by the Contract specifications covering the manner of selecting the communities. It is important that this distribution pattern be considered in interpreting all data.

SECTION III

COMMUNITY SEWER SYSTEMS AND THEIR SERVICE AREAS AND FUNCTIONS

Questions Covered by the Survey

Functions of multi-community sewer system jurisdictions

Types of sewer systems utilized by selected communities

Total areas and populations served by collection and interceptor sewers of various types

Correlations between population densities and areas served

Extent of unsewered areas and unserved populations

Relationship between types of sewers and unsewered areas, and regions of the United States

Miles and types of sewers recently constructed

Capacity ratios of combined interceptor sewers

Number of personnel employed in sewer service and treatment facilities

SECTION III

COMMUNITY SEWER SYSTEMS

In the case of both combined sewers and separate sanitary sewers, where no treatment is yet provided for the flows, the waste waters are discharged raw into receiving waters in much the same manner as flows from separate storm sewers. Untreated combined sewer overflows represent sources of pollution. Since separate storm waters contain contaminants of varying characteristics and degrees of concentration, discharges of these flows are also sources of water pollution which must not be overlooked at the time when interest and concern are being focused on the combined sewer overflow problem in the United States.

No study of the use of combined sewer systems and of associated overflow and discharge problems in the United States can be meaningful without basic information on the types of sewers and the extent to which they are utilized by communities. The population served by each type of sewer; the area served; and the mileage of each type of sewer are of specific importance. Furthermore, any evaluation of the combined sewer problem must be put into perspective with information on the extent and location of unsewered urban areas and the populations which must be provided with waste water collection and transportation facilities at an early time to ensure the health, safety and convenience of urban areas and their residents.

Information is also needed on the extent of sewer construction in recent years, particularly as to the types of sewer systems being constructed and the design ratio of wet-weather to dry-weather capacity for combined interceptor sewers. Such data reflect current thinking with respect to the continued use of combined sewer systems and give an indication of the practice being followed to provide capacity in combined interceptor sewers to handle the flows resulting from storms of low intensity and short duration.

Of the 200 million people in this nation, roughly two-thirds live in urbanized areas, and most urban dwellers have collected in metropolitan complexes. The Bureau of Census has identified roughly 250 such "clusters," and has designated them as Standard Metropolitan Statistical Areas. The number is growing. Virtually all include numerous independent political subdivisions, woven together by common geographical and economic needs and conditions. The concentrated population has caused many political scientists to advocate the provision of certain municipal services through counties or some type of metropolitan government or regional agency. With the help of the sanitary engineering profession, local governments have utilized many regional types of organizations to provide waste-water collection, treatment and disposal service. These take the form of:

(1) Sanitary districts

(2) Joint municipal operations

(3) Contracts among governments, generally with the central city offering to receive and treat sewage from its suburbs at an agreed unit price

(4) Annexation of areas into single municipal entities

(5) Other variations of joint or partnership sewerage works ventures.

In general, these multi-community service agencies preserve the autonomy of the local governments served while enabling them to participate in a regional, urban activity. The motivating reason for the trend is basically economy, flexibility and efficiency of functions.

Out of these arrangements comes the question of split responsibility between the contributor of the wastes and the receiver of them. For example: Who is responsible for overflows? Should proposed prevention of overflows and their resulting pollution problem involve separation of storm and sanitary sewage in the contributing community in order to prevent overflow? If overflow waste treatment methods must be initiated, who should do it—the contributor or the receiver of the combined sewage—and who should pay? Who will benefit economically from reduced flows resulting from separation projects, elimination of infiltration or stringent regulation of discharges into sewers such as from roof leaders, foundation drains, air conditioners or industries?

One of the anomalies of the present joint-system or sanitary district trend is that many fringe communities served by these regional entities make use of separate sewer systems. In many cases, these separate sanitary flows then discharge into sewers which carry combined sanitary and storm water from the central city of other contributing communities which still use combined sewers. The net result of such conditions is that this separate sanitary sewage becomes combined sewage by "association" and adds to the overflow problem.

The nature and general characteristics of many of these regional waste-water organizations are described in Appendix H.

Types of Sewers

Table III-A lists the type of sewer service provided to the 51,079,246 persons served by the jurisdictions surveyed. Of the total population of such communities, 65 percent (34,080,094) make use of combined sewers. It is significant to note that combined sewers are used most extensively in basin 1, an area with many old, well-established cities where 81 percent (11,120,300) of the population surveyed utilize such sewers. On the other hand, the greatest use of separate sanitary sewers was reported in basin 12, an area which has experienced great population growth since World War II. Approximately 92 percent (1,120,500) of the population of the communities surveyed in this basin make use of separate sewers. It is also pertinent to note that the unsewered population does not exceed 10 percent of the total population in any basin and, on a national basis, represents only 3 percent (1,574,400) of the total population of the surveyed communities. Table III-A also shows that the population served by separate storm sewers in the communities surveyed ranged from a low of 4 percent in basin 11 to a high of 62 percent in basin 15; and that 19 percent of the total surveyed population had separate storm sewers as compared to 32 percent with separate sanitary sewers.

Figure III is a graphic representation of the projected number of persons served by combined sewers in each state as compared to the total sewered population of the state. The latter figures were obtained from the 1962 Inventory—Municipal Waste Facilities, PHS 1065.

TABLE III-A—POPULATION (IN 1,000's) AND PERCENT SERVED BY TYPE OF SERVICE AND DRAINAGE BASIN

Basin No.	Separate Sanitary Sewers	%	Combined Sewers	%	Total Sewered Population	%	Unsewered Population	%	Total Population Reported	Separate Storm Sewers	%
1	2,135.4	15	11,120.3	81	13,255.7	96	505.3	4	13,761.0	1,060.0	8
2	2,961.5	55	2,405.7	44	5,367.2	99	29.1	1	5,396.3	2,763.6	51
3	658.1	58	400.5	36	1,058.6	94	65.4	6	1,124.0	86.1	8
4	110.8	77	30.3	21	141.1	98	3.4	2	144.4	8.0	6
5	1,224.5	25	3,268.7	67	4,493.2	92	379.0	8	4,872.1	815.6	17
6	701.7	53	581.2	44	1,282.9	97	42.7	3	1,325.5	356.7	27
7	1,395.2	20	5,468.2	79	6,863.4	99	85.8	1	6,949.1	1,149.1	16
8	1,979.7	33	3,816.6	65	5,796.3	98	133.3	2	5,929.5	1,221.8	21
9	1,889.3	52	1,635.3	45	3,524.6	97	90.3	3	3,614.8	749.2	21
10	151.0	72	52.8	25	203.8	97	6.7	3	210.5	71.0	34
11	12.9	50	12.7	49	25.6	99	0.2	1	25.9	1.1	4
12	1,120.5	92	78.6	6	1,199 1	98	19.1	2	1,218.2	219.5	18
13	455.2	27	1,088.9	64	1,544.1	91	154.9	9	1,699.0	194.2	11
14	488.0	35	854.0	61	1,342.0	96	56.7	4	1,400.8	488.0	35
15	84.5	68	39.5	32	124.0	100	—	0	124.0	76.5	62
16	56.7	84	10.0	15	66.7	99	0.6	1	67.3	34.5	51
Total	15,424.7	32	30,863.2[1]	65	46,287.9[1]	97	1,574.4	3	47,862.3[1]	9,539.5	19

NOTE: [1] 33 communities did not report a breakdown of their population by type of sewered area. Populations for these cities are not included in the table. However, these communities did report that 3,216,921 persons were served by combined sewers. Adjusting for these communities increases the total population reporting to 51,079,246, the combined sewer population to approximately 34,080,094 and the total sewered population to 49,504,821.

Area and Population Served

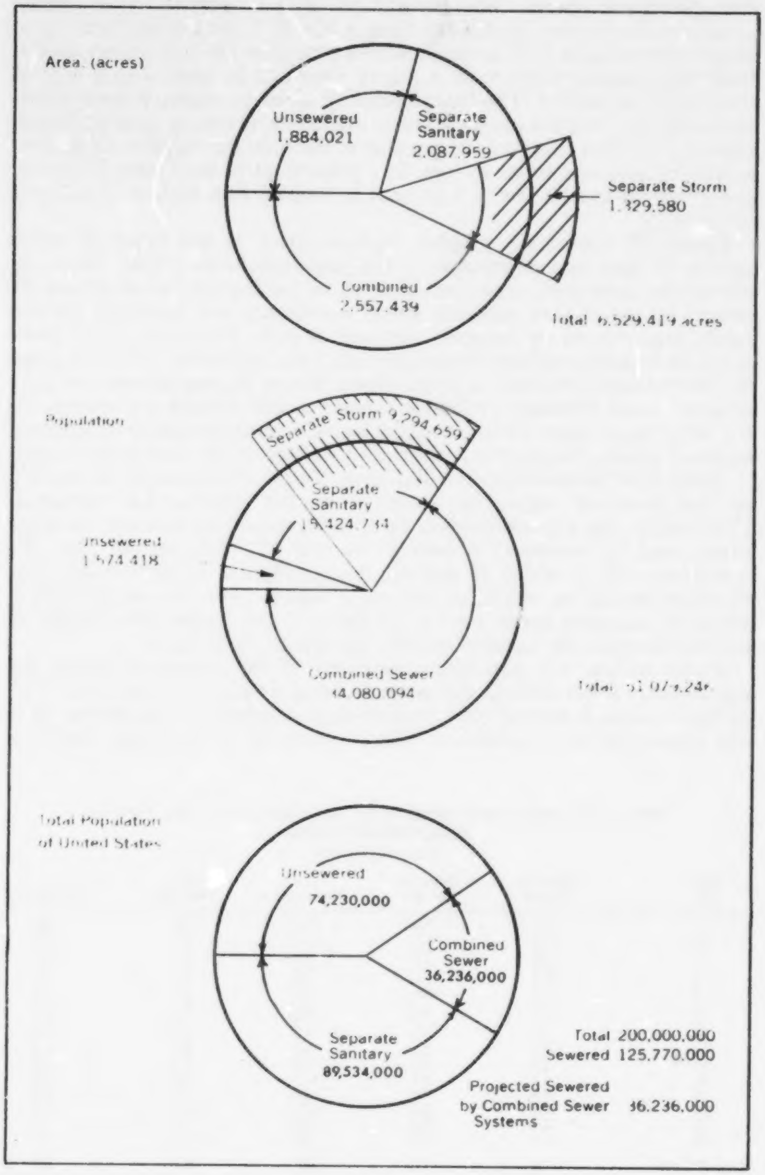
Table III-B summarizes the data reported by the communities surveyed on the basis of area for each basin. The total area reported amounted to 6,530,000 acres. The table shows that 70 percent (4,645,500 acres) is sewered land, while 30 percent (1,884,000 acres) is not. Of the sewered area, 2,088,000 acres, representing 33 percent of the total area surveyed, is served by separate sanitary sewers. The percentage of land with such sewers in the communities surveyed ranged from a low of

TABLE III-B—AREA (IN 1,000 ACRES) AND PERCENT BY TYPE OF SERVICE AND DRAINAGE BASIN

Basin No.	Separate Sanitary Sewers	%	Combined Sewers	%	Total Area Sewered	%	Unsewered	%	Total Area Reported	Separate Storm Sewers	%
1	243.1	16	497.0	32	740.1	48	815.3	52	1,555.4	177.3	11
2	149.4	41	174.5	48	323.9	89	43.1	11	367.11	134.4	37
3	97.4	53	68.5	38	165.9	91	16.1	9	182.0	14.6	8
4	21.3	84	2.7	11	24.0	95	1.3	5	25.3	0.5	2
5	242.2	25	390.4	40	632.6	65	349.5	35	982.2	135.7	14
6	195.8	57	114.2	33	310.0	90	32.2	10	342.2	167.5	49
7	234.3	31	412.0	55	646.3	86	104.2	14	750.5	182.5	24
8	267.3	33	319.5	40	586.8	73	211.2	27	798.0	172.8	22
9	228.6	38	188.8	31	417.4	69	185.6	31	602.9	92.1	15
10	43.7	78	8.9	16	52.6	94	3.3	6	55.8	12.8	23
11	2.8	41	3.6	53	6.4	94	0.4	6	6.9	0.4	5
12	197.1	88	4.9	2	202.0	90	21.9	10	223.9	133.1	60
13	77.9	28	120.3	44	198.2	72	78.4	28	276.6	39.9	14
14	74.0	61	37.6	31	111.6	92	10.0	8	121.6	54.8	45
15	6.4	37	3.6	21	10.0	58	7.2	42	17.2	7.0	41
16	6.6	53	1.6	12	8.2	65	4.3	35	12.5	4.0	32
Total	2,088.0	33	2,348.0[1]	37	4,436.0[1]	70	1,884.0	30	6,320.0[1]	1,329.6	21

NOTE: [1] 25 communities did not report a breakdown of their area by type of sewered area and 31 did not report any area information. Therefore data for such communities are not included in the table. The 25 communities mentioned above, did report that combined sewers served 209,393 acres. Adjusting for these communities increases the total reported area to 6,530,000 acres and the area served by combined sewers to 2,557,000 acres, and the total area sewered to 4,645,400.

FIG. III. AREA AND POPULATION OF JURISDICTIONS SURVEYED BY TYPE OF SEWER SERVICE.



16 percent in basin 1 to a high of 88 percent in basin 12. The survey revealed that 37 percent (2,557,000 acres) of the total area surveyed had combined sewers. The percentage of land served by combined sewers in the various basins ran from a low of 2 percent in basin 12 to 55 percent in basin 7. It is significant to note that the unsewered area in individual basins ranges from a low of 5 percent in basin 4 to a high of 52 percent in basin 1. The higher priority given to sanitary sewers over storm sewers, where separate systems are in use, is clearly indicated once again by the fact that only 21 percent of the area surveyed is reportedly served by separate storm sewers. The percentage of land served by such sewers varies from a low of 2 percent in basin 4 to a high of 60 percent in basin 12.

Figure IV presents a graphic representation of the types of sewer service by area and population of the jurisdictions surveyed. These, as previously indicated, were limited to those having combined sewers. It should be noted that separate storm sewers are not provided for the entire area served by separate sanitary sewers. This is expected inasmuch as separate sanitary sewers are usually installed in the initial stage of development, whereas separate storm sewers frequently are not constructed until drainage problems become acute. Combined sewers, on the other hand, while having a higher initial cost as compared to separate sanitary sewers, do provide for surface drainage of the area to be served.

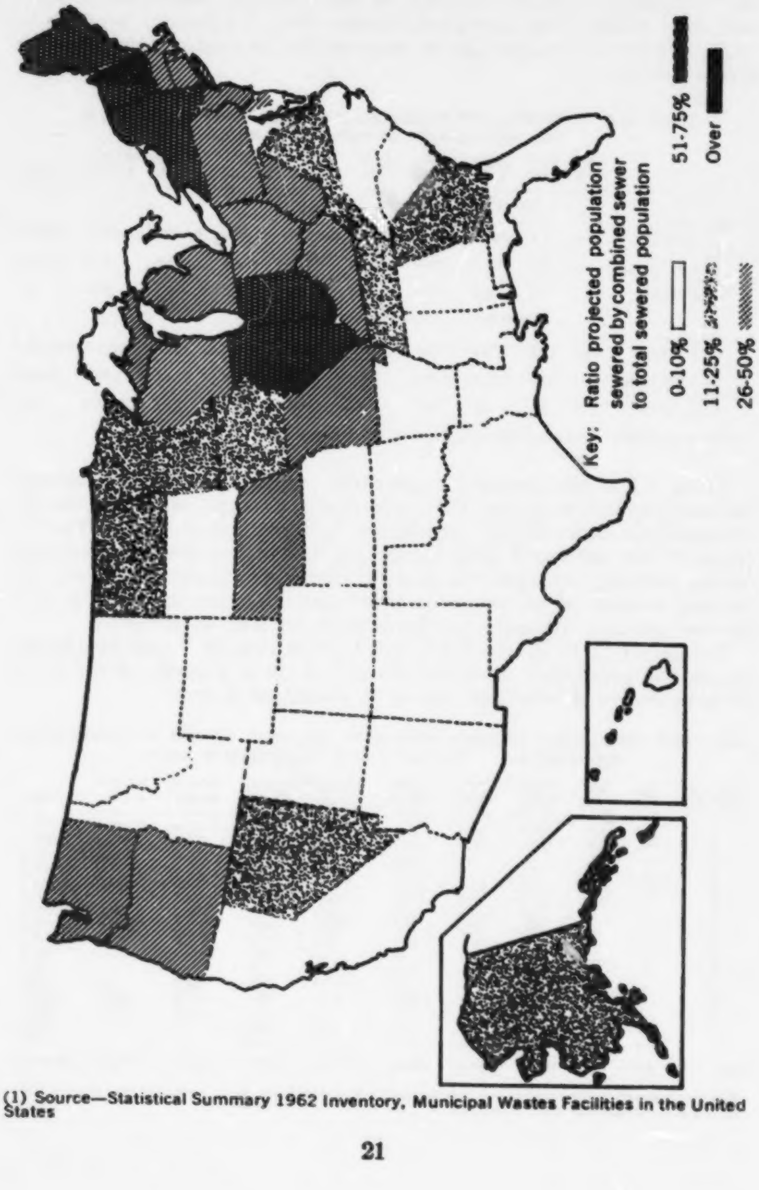
Table III-C summarizes the data from Tables III-A and III-B and IV on the basis of population density for the jurisdictions surveyed. (Nationally, the population density of those served by separate sanitary sewers and by combined sewers is 7.4 and 13.1 persons per acre, respectively.) In 11 of the 16 regions, the population density of the communities served by combined sewers is higher than the corresponding value for sanitary sewer service. In three of the basins, the density is double the value for sanitary sewers, and in two, it is triple.

In all basins, the population densities of the unsewered areas are significantly lower than in the sewered areas, as would be expected. The national average for the communities with unsewered areas is less than one person per acre, indicating that it is usually the underdeveloped or

TABLE III-C—POPULATION DENSITY BY DRAINAGE BASIN AND TYPE OF SEWER SERVICE AREA
(Population/Acre)

Basin No.	Separate Storm	Separate Sanitary	Combined	Total Sewered	Unsewered
1	6.0	8.8	22.4	18.0	0.6
2	20.6	19.8	13.8	16.6	0.7
3	5.9	6.8	5.8	6.2	4.1
4	16.0	5.2	11.2	5.7	2.6
5	6.0	5.1	8.4	7.1	1.1
6	2.1	3.6	5.1	4.1	1.3
7	6.3	6.0	13.2	9.4	0.8
8	7.1	7.4	11.9	7.4	0.6
9	8.1	8.2	8.7	6.0	0.5
10	5.5	3.5	5.9	3.8	2.0
11	2.9	4.6	3.5	3.8	0.6
12	1.6	5.7	16.1	5.9	0.9
13	4.9	5.8	9.0	6.1	2.0
14	8.9	6.6	22.5	11.5	5.9
15	10.9	13.2	11.0	7.2	—
16	8.6	8.6	6.3	5.4	0.1
Avg. of Total	7.0	7.4	13.1	10.5	0.8

FIG. IV. RELATIVE USE OF COMBINED SEWERS COMPARED TO TOTAL SEWERED POPULATION(1) BY STATES


Key: Ratio projected population sewered by combined sewer to total sewered population
0-10%
11-25%
26-50%
51-75%
Over

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(1) Source—Statistical Summary 1962 Inventory, Municipal Wastes Facilities in the United States

undeveloped regions which have not been provided with public sewers. Some of these areas are intended for development as parks, airports and lakes.

Table III-D summarizes, on a national basis, by population groups, the population, area and density of the surveyed communities using combined sewers. The increase in density from 2.1 persons per acre to 21.9, with the increasing size of communities, is readily apparent as a general pattern.

TABLE III-D—SURVEYED AND PROJECTED COMBINED SEWER POPULATION, AREA AND DENSITY BY POPULATION GROUP

	0-500	501-1,000	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
			Survey as Reported							
A Population (in 1,000's)	0.6	7.6	230.4	361.3	895.4	2,249.7	3,362.0	6,322.8	17,433.4	30,863.2
B Area (in 1,000 Acres)	—	3.7	61.5	75.4	159.9	283.1	418.3	548.8	797.4	2,348.0
C Density (Pop./Acre)	—	2.1	3.8	4.9	5.6	8.0	8.0	11.5	21.9	13.1
			Projected for United States[1]							
A Population (in 1,000's)	14.0	71.9	873.9	911.0	1,865.3	2,385.3	3,853.9	6,719.8	19,541.4	36,236.0
B Area (in 1,000 Acres)	—	34.7	234.8	214.0	337.4	313.3	472.4	581.6	840.8	3,029.0
C Density of (Pop./Acre)	—	2.1	3.7	4.3	5.5	7.7	8.2	11.5	23.2	12.0

[1] Includes information from cities reporting only total population or area.

Table III-D also shows the projected population, area and density for each population group. The projections, of course, only apply to the communities under 25,000 population that were not surveyed. The increase in the estimated total population and area served by combined sewers naturally changes the density figures. On a national basis, the average density of all projected combined sewer service areas is 12.0 persons per acre compared to 13.0 persons per acre as surveyed.

Tables III-E, III-F and III-G list, by drainage basin and population group, the population, area and density of those portions of the jurisdictions surveyed which are served by combined sewers.

TABLE III-E—POPULATION (IN 1,000's) SERVED BY COMBINED SEWERS IN COMMUNITIES SURVEYED BY POPULATION GROUP AND DRAINAGE BASIN

Drainage Basin No.	0-500	501-1,000	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
1	0.4	1.1	44.0	48.3	186.1	561.5	947.0	2,134.9	7,196.9	11,120.2
2	—	0.6	34.0	50.8	90.1	55.4	292.3	482.0	1,400.5	2,405.7
3	—	—	—	—	10.4	9.3	122.7	150.0	108.1	400.5
4	—	—	2.8	—	1.1	—	—	26.4	—	30.3
5	0.2	5.0	75.3	99.2	279.2	416.0	543.8	892.0	958.0	3,268.7
6	—	0.9	12.1	29.0	74.1	65.5	76.0	322.7	—	580.3
7	—	—	22.5	44.6	123.3	514.2	643.6	620.0	3,500.0	5,468.2
8	—	—	22.9	28.2	47.8	556.1	490.9	663.6	2,007.0	3,816.5
9	—	—	8.3	26.7	15.8	4.3	77.3	417.0	1,085.9	1,635.3
10	—	—	—	—	—	—	52.8	—	—	52.8
11	—	—	1.7	—	11.0	—	—	—	—	12.7
12	—	—	—	—	—	—	40.0	37.6	1.0	78.6
13	—	—	6.3	21.5	56.5	66.0	40.1	472.5	426.0	1,088.9
14	—	—	—	—	—	—	—	104.0	750.0	854.0
15	—	—	—	5.0	—	0.5	34.0	—	—	39.5
16	—	—	0.5	8.0	—	—	1.5	—	—	10.0
Total	0.6	7.6	230.4	361.3	895.4	2,248.8	3,362.0	6,322.7	17,433.4	30,862.2[1]

[1] Population served by combined sewers not reported by 33 communities. By adjusting for this, the population served would be approximately 34,080,000.

TABLE III-F—AREA (IN 1,000's OF ACRES) SERVED BY COMBINED SEWERS IN COMMUNITIES SURVEYED BY POPULATION GROUP AND DRAINAGE BASIN

Drainage Basin No.	0-500	501-1,000	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
1	—	0.4	22.3	20.8	37.2	65.0	90.9	111.2	149.2	497.0
2	—	0.3	10.2	10.2	12.5	5.6	34.0	43.6	58.1	174.5
3	—	—	—	—	2.4	0.7	22.5	14.0	28.9	68.6
4	—	—	—	—	0.1	—	—	2.6	—	2.7
5	—	2.7	10.7	12.9	46.3	53.6	81.7	102.9	79.5	390.3
6	—	0.3	1.9	4.1	12.5	9.6	7.0	34.8	44.0	114.2
7	—	—	5.6	7.7	19.6	74.5	92.1	68.6	144.0	412.1
8	—	—	7.2	6.2	13.1	63.5	54.4	69.8	105.3	319.5
9	—	—	1.7	5.9	2.9	0.1	16.8	39.0	122.3	188.7
10	—	—	—	—	—	—	8.9	—	—	8.9
11	—	—	0.3	—	3.3	—	—	—	—	3.6
12	—	—	—	—	—	—	1.1	3.8	—	4.9
13	—	—	1.6	5.2	10.0	10.5	6.1	48.9	38.0	120.3
14	—	—	—	—	—	—	—	9.6	28.0	37.6
15	—	—	—	1.2	—	—	2.4	—	—	3.6
16	—	—	—	1.2	—	—	0.3	—	—	1.5
Total	0	3.7	61.5	75.4	159.9	283.1	418.3	548.8	797.3	2,348.0[1]

[1] Area served by combined sewers was not reported by some communities. By adjusting for this, the area served would be approximately 2,557,000 acres.

TABLE III-G—DENSITY OF AREAS SERVED BY COMBINED SEWERS BY POPULATION GROUP AND DRAINAGE BASIN (POP./ACRE)

Drainage Basin No.	0-500	501-1,000	1,001-5,000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
1	—	2.7	2.0	2.3	5.0	8.7	10.4	19.2	48.2	22.4
2	—	2.0	3.3	5.0	7.2	9.0	8.6	11.0	24.1	13.8
3	—	—	—	—	4.3	13.3	5.4	10.7	3.7	5.8
4	—	—	—	—	11.0	—	—	10.2	—	11.2
5	—	1.8	7.0	7.7	6.0	7.8	6.7	8.7	12.0	8.4
6	—	3.0	6.4	7.1	5.9	6.8	10.8	9.3	—	5.1
7	—	—	4.0	5.8	6.3	6.9	7.0	9.0	24.3	13.2
8	—	—	3.2	4.6	3.7	8.8	9.1	9.5	19.0	11.9
9	—	—	4.9	4.5	5.5	43.0	4.6	10.9	8.9	8.7
10	—	—	—	—	—	—	5.9	—	—	5.9
11	—	—	5.7	—	3.3	—	—	—	—	3.5
12	—	—	—	—	—	—	36.4	9.9	—	16.1
13	—	—	3.9	4.1	5.6	6.3	6.6	9.7	11.2	9.0
14	—	—	—	—	—	—	—	10.8	26.8	22.5
15	—	—	—	4.2	—	—	14.2	—	—	11.0
16	—	—	—	6.7	—	—	5.0	—	—	6.3
Total	—	2.1	3.8	4.9	5.6	8.0	8.0	11.5	21.9	13.1

Miles of Sewers

Table III-H lists the total 116,372 miles of separate sanitary, separate storm and combined sewers in the surveyed communities by drainage basins. The total miles of collector and interceptor sewers in the surveyed communities are divided as follows: 44,286 miles of separate sanitary sewers; 17,151 miles of separate storm sewers, and 54,935 miles of combined sewers.

TABLE III-H—MILES AND PERCENT OF SEWERS BY TYPE AND DRAINAGE BASIN IN JURISDICTIONS SURVEYED

	Miles of Collection Sewer							Miles of Interceptor							Total Miles of Sewers	
No.	Separate Sanitary	%	Combined	%	Separate Storm	%	Total	Separate Sanitary	%	Combined	%	Separate Storm	%	Total	Collector & Interceptor	Combined & Sanitary
1	6,615	32	11,548	55	2,798	13	20,961	348	37	569	60	30	3	947	21,908	19,080
2	2,918	38	2,654	34	2,129	28	7,701	179	47	196	51	9	2	384	8,085	5,947
3	2,172	67	793	25	254	8	3,219	309	66	142	30	18	4	469	3,688	3,416
4	461	86	52	10	23	4	536	18	75	6	25	0	0	24	560	537
5	4,690	32	8,378	56	1,751	12	14,819	414	39	592	56	49	5	1,055	15,874	14,074
6	1,964	45	1,540	35	905	20	4,409	116	29	195	50	83	21	394	4,803	3,815
7	3,705	25	9,417	64	1,644	11	14,766	302	25	842	70	55	5	1,199	15,965	14,266
8	4,941	29	8,522	51	3,329	20	16,792	589	43	602	43	193	14	1,384	18,176	14,654
9	5,242	48	3,975	37	1,678	15	10,895	910	78	109	9	146	13	1,165	12,060	10,236
10	508	63	207	25	95	12	810	8	80	1	10	1	10	10	820	724
11	10	15	48	72	9	13	67	3	60	2	40	0	0	5	72	63
12	4,153	82	32	1	860	17	5,045	0	0	3	100	0	0	3	5,048	4,188
13	1,884	33	3,266	58	526	9	5,676	180	62	66	23	42	15	288	5,964	5,396
14	1,246	50	945	38	293	12	2,484	52	31	65	39	50	30	167	2,651	2,308
15	203	51	134	34	58	15	395	27	25	11	10	71	65	109	504	375
16	94	62	18	12	39	26	151	25	53	5	12	13	30	43	194	142
Total	40,806	37	51,529	47	16,391	16	108,726	3,480	45	3,406	45	760	10	7,646	116,372	99,221

Table III-I summarizes the total mileage of combined sewers by drainage basins. It also lists the miles of combined sewers per 1000 persons served which ranges from 0.45 to 5.58 with an average of 1.79 (559 persons per mile). In addition, it lists miles of combined sewers per 1000 acres drained which ranges from 7.1 to 40.3 with an average of 23.4 (42.7 acres per mile of combined sewer).

TABLE III-I—TOTAL MILEAGE AND RATIOS OF COMBINED SEWERS TO POPULATION AND AREA IN JURISDICTIONS SURVEYED BY DRAINAGE BASINS

	Total Mileage of Combined Sewers		
Basin No.	Collector and Interceptor	Per 1,000 Combined Sewer Population	Per 1,000 Acres Combined Sewer Area
1	12,117	1.09	24.4
2	2,850	1.18	16.3
3	935	2.34	13.6
4	58	1.92	21.5
5	8,970	2.74	23.0
6	1,735	3.08	15.2
7	10,259	1.88	24.9
8	9,124	5.58	28.6
9	4,084	2.80	21.7
10	208	3.94	23.4
11	50	3.94	13.9
12	35	.45	7.1
13	3,332	3.06	27.6
14	1,010	1.18	26.9
15	145	3.67	40.3
16	23	2.30	15.4
Total	54,935	1.79	23.4

Figure V is a visual representation indicating the relative mileage of combined, separate storm, and separate sanitary sewers in the jurisdictions surveyed. It shows the distribution of each type for collector sewers, interceptor sewers and the total miles of all sewers.

Recent Sewer Construction

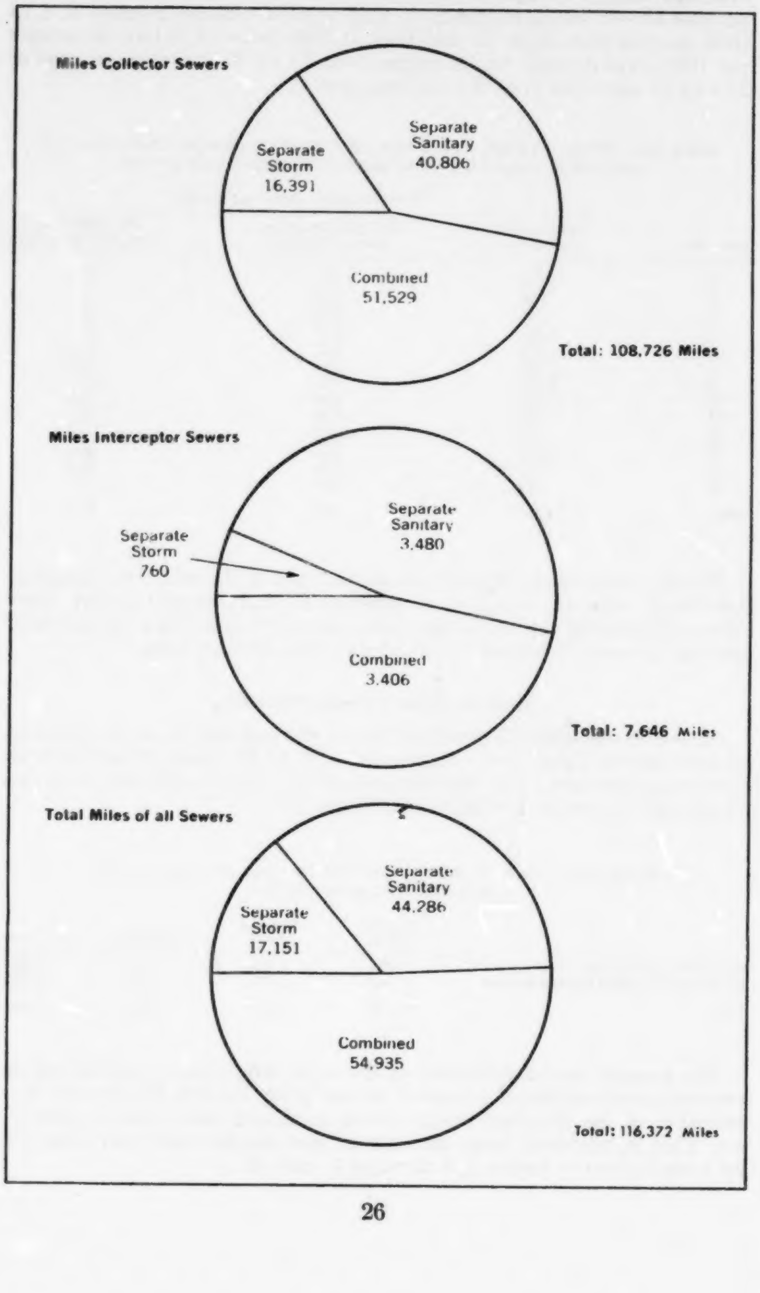
Surveyed jurisdictions reported that in the past ten years 15,132 miles of new sewers have been constructed and 2,159 miles of sewers have been reconstructed. The distribution of the construction between the three types of sewer is indicated in Table III-J.

TABLE III-J—MILES OF SEWER CONSTRUCTED AND RECONSTRUCTED IN JURISDICTIONS SURVEYED

	Separate Sanitary	Separate Storm	Combined	Total
Miles-new construction	9,515	4,420	1,197	15,132
Miles-built to replace existing facilities	612	801	746	2,159
Total	10,127	5,221	1,943	17,291

The geographical distribution of the areas which have constructed or reconstructed combined sewers in recent years follows the general distribution of the drainage basins where combined sewers are in general use. That is, relatively large amounts of such construction were reported by jurisdictions in basins 1, 5 through 9, and 13.

FIG. V. MILES OF SEWER IN JURISDICTIONS SURVEYED



Miles Collector Sewers

Miles Interceptor Sewers

Total Miles of all Sewers

It is evident, and of importance to the study findings, that combined sewers are still being built to serve new areas and are being reconstructed in many jurisdictions.

Capacity of Combined Interceptor Sewers

An important factor in determining how often combined sewers will overflow is the capacity of the interceptor sewers. The capacity is usually rated as a multiple of the average dry-weather flow. Thus, if the wet-weather flow capability of the interceptor is double the dry-weather flow, it would be able to carry twice the volume of the average flow to the water pollution control plant during a storm water runoff period. Flows resulting from precipitation of low intensity and duration would thus go directly to the treatment plant. The larger the flow which can be transported by the interceptor, the fewer overflow events there will be at the connection of the collector and interceptor sewer.

The cost of providing a water pollution control plant and interceptor sewers capable of handling the entire flow from combined collection sewers, would be astronomical. Furthermore, such facilities would be utilized only a small portion of the time. Since it is not considered practical to follow this course of action, it has been necessary for jurisdictions to use a more realistic approach in dealing with this problem. This involves an analysis of the consequences of smaller capacity interceptors, and a careful evaluation of the location, effect and anticipated number and duration of overflows, as well as the relative cost of correction measures for combined sewer overflows.

A total of 146 jurisdictions reported wet-weather to dry-weather combined sewer interceptor capacity ratios. The ratios ranged from 1:1 to 8:1. The median ratio was 4:1, indicating that, for these jurisdictions, "stand-by" capacity has been provided in the combined sewer interceptor to handle a portion of the wet-weather flows.

Personnel

Sewer systems and water pollution control plants must have an adequate number of trained, qualified personnel if the facilities are to be properly operated and maintained. An indication of the relative capabilities of engineering staffs can be determined by comparing the number of registered professional engineers and employees with an engineer-in-training certificate in different size organizations. In recent years professionalism in the operation of water pollution control plants and their appurtenant facilities has been achieved through certification as a treatment plant operator.

As a part of the study, questions were asked to determine the total number of full and part-time employees working on sewer and waste water treatment plant functions for the jurisdictions surveyed, the number of registered engineers and engineers-in-training employed, and the number of certified treatment plant operators. The findings are shown in Table III-K. The 527 jurisdictions responding had a total of 19,559 full or part-time employees, including 798 registered professional engineers or engineers-in-training and 1,283 certified plant operators. There is an average of less than one registered engineer or engineer-in-training responsible for sewer and treatment plant functions in jurisdictions of less than 25,000 population. For these smaller communities, consulting engineers are often utilized to advise on operation and maintenance problems. All jurisdictions often use consulting engineers to design and inspect new construction.

There are approximately 2 or less certified plant operators per jurisdiction for those of less than 50,000 population, although the number in jurisdictions of over 500,000 population average 16.9. Many of these have multiple treatment plants; two, three or more treatment plants per jurisdiction is not uncommon. For all population groups except that of over 500,000, the average number of certified plant operators is not enough to allow such personnel to be on duty around the clock.

TABLE III-K—NUMBER OF SPECIALLY TRAINED SEWER SYSTEM PERSONNEL BY POPULATION GROUP

Population Group	Number Jurisdictions	Total Employees	Employees per Jurisdiction	Total Registered Engineers and Engineers-in-Training	Registered Engineers and Engineers-in-Training per Jurisdiction	Total Certified Plant Operators	Certified Plant Operators per Jurisdiction
0-500	2	2	1.0	—	—	—	—
501-1,000	10	24	2.4	—	—	1	0.1
1,001-5,000	113	539	5.0	14	0.1	51	0.5
5,001-10,000	82	666	8.0	27	0.3	76	0.9
10,001-25,000	77	764	10.0	41	0.5	135	1.7
25,001-50,000	103	1,447	14.0	82	0.8	220	2.1
50,001-100,000	68	1,710	25.0	106	1.6	182	3.7
100,001-500,000	52	3,790	73.0	171	3.3	279	5.4
Over 500,001	20	10,617	531.0	357	18.3	339	16.9
Total	527	19,559	37.0	798	1.5	1,283	2.4

SECTION IV

OVERFLOWS AND THEIR EFFECTS

Questions Covered by the Survey

Numbers of overflows; locations; number per length of combined sewers and population served

Land use at overflow points

Water use in the vicinity of overflow points

Nature of receiving waters at overflow points

Pollutional effects of overflows on the environment

Number and duration of overflow events

SECTION IV

OVERFLOWS AND THEIR EFFECTS

The discharge of combined sewer overflows into receiving waters results in oxygen consuming bacterial and inorganic pollutional matter entering the region's water resources. There is a dearth of precise information on the amount and character of these pollutants. The survey endeavored to appraise the effects of this added pollution load on the land and water environment in urban areas. This involved the collection of data on:

1. The number of overflow points in the combined sewer system and their locations, i.e., from the sewers, pumping stations or treatment plants
2. The land uses in the vicinity of the overflow points
3. The uses of the waters that receive overflows
4. The dilution afforded the discharged waste waters by the receiving waters
5. The type of receiving waters, i.e., rivers, lakes, tidewaters
6. The frequency and duration of such overflows.

The economic impact of these polluting overflows, in terms of anticipated national growth and urbanization, requires consideration of all effects of such discharges on the total environment. These effects include:

1. Water deterioration and loss of value and usability of these resources for multiple purposes
2. Damage to the water for recreational purposes
3. Creation of local nuisances by shoaling of storm-carried debris and sewage solids
4. Creation of offensive appearances of waterways, thus denying the public's "right to enjoy" the beauties of natural water areas and surrounding lands.

Determining the number of overflow points and their locations was the first essential step in making these appraisals. Table IV-A summarizes these data for the jurisdictions surveyed by drainage basins. It should be noted that the totals do not include projections for all jurisdictions with combined sewers. Of the 14,212 overflow points, 4,505 or nearly a third are in basin 1 (Northeast); and 3,172 are in basin 5 (Ohio River). Nearly 70 percent (9,860) of the overflows occur at points in the combined sewer system. The remainder take place at bypasses at treatment plants (532), pumping stations (1,514), and other locations (2,306). Five percent (755) of the overflows come from separate sanitary sewers, frequently caused by the entry of storm water through illegal roof leaders, through leaky manholes and other sources which produce flows that pumping stations are unable to handle.

TABLE IV-A—NUMBER AND SOURCE OF SEWAGE OVERFLOWS BY DRAINAGE BASIN

Basin No.	Combined Sewers	Treatment Plant Bypass	Pumping Station Bypass		Not Otherwise Identified	Total	Per Cent of Total
			Combined Sewer	Separate Sewer			
1	2,615	81	107	52	1,650	4,505	32
2	951	33	44	17	66	1,111	8
3	72	15	20	61	18	186	1
4	19	3	—	—	1	23	—
5	2,269	119	225	150	409	3,172	22
6	986	40	49	46	29	1,150	8
7	1,223	92	102	91	10	1,518	11
8	1,085	54	72	56	32	1,299	9
9	403	47	41	172	48	711	5
10	3	3	2	—	6	14	—
11	2	2	—	—	—	4	—
12	9	3	5	—	—	17	—
13	186	34	77	101	29	427	3
14	23	3	15	7	8	56	—
15	13	3	—	—	—	16	—
16	1	—	—	2	—	3	—
Total	9,860	532	759	755	2,306	14,212	
Percent of Total	70	4	5	5	16	100	
Number of Jurisdictions Reporting	493	388	237	160	87	—	

Table IV-B lists the ratio of overflows to sewer length, population and area. For the jurisdictions surveyed, and considering only combined sewer overflows, the data show an average of 1.8 overflow points for each ten miles of combined sewer; a little less than 4.2 overflow points per 1,000 acres, and 0.32 overflow points per 1,000 population. Region 6 (Lake Erie), had ratios approximately 50 percent higher than the other basins and basin 10 (Southwest—Lower Miss.), had extremely low ratios.

For all overflows, ratios were calculated for the total population and area inasmuch as bypasses and many other sources of overflows could be a function of the total service area. The ratio of all overflows per 100 acres served was 3.2 while the ratio per 1000 sewered population was approximately 0.3.

TABLE IV-B—RATIO OF NUMBER OF OVERFLOWS TO SEWER LENGTH, POPULATION AND AREA BY DRAINAGE BASIN

Basin No.	Combined Sewer Overflows			All Overflows	
	Per Mile Combined Sewer	Per 1,000 Acres[1]	Per 1,000 Pop.[1]	Per 1,000 Total Sewered Pop.[2]	Per 1,000 Total Sewered Acres[2]
1	0.22	5.27	0.235	0.340	6.08
2	0.33	5.45	0.396	0.207	3.44
3	0.08	1.05	0.180	0.176	1.12
4	0.33	7.06	0.627	0.163	0.96
5	0.25	5.81	0.694	0.705	5.10
6	0.57	8.67	1.515	0.897	3.71
7	0.12	2.97	0.224	0.220	3.35
8	0.12	3.43	0.284	0.224	2.21
9	0.10	2.14	0.246	0.202	1.70
10	0.01	0.34	0.064	0.069	0.27
11	0.04	0.56	0.157	0.156	0.62
12	0.26	1.84	0.115	0.058	0.34
13	0.06	1.55	0.171	0.277	2.16
14	0.02	0.61	0.027	0.042	0.50
15	0.09	3.61	0.329	0.129	1.60
16	0.04	0.80	0.100	0.045	0.37
Average	0.18	4.19	0.320	0.307	3.21

[1] Served by combined sewers in jurisdictions surveyed.

[2] In jurisdiction surveyed.

Land Use at Overflow Points

Summary Table IV-C and Figure VI show the number of overflow points in the vicinity of different types of land use. Detailed tables for each source of pollution (combined sewer overflow point, treatment plant bypass, etc.), by drainage basin, are included in Appendix J. Of the 10,701 combined sewer overflows, 3,454 are in the vicinity of industrial land, and 3,261 are in the vicinity of residential land. Other major land uses reported in the nearby area of overflow points are recreation (1,474) and commercial (1,303). Non-polluted waters in the vicinity of land used for residential and recreational purposes is especially important to people living in a highly urbanized society.

The 615 treatment plant bypasses are somewhat less objectionable from the standpoint of their effect on urban land uses. A total of 218 bypasses are found in the vicinity of land used for industrial purposes and 135 are located where land is classified as being vacant.

Pumping station bypasses, which total 1,319, are located in the vicinity of land used for the following purposes: residential (410), industrial (290), and vacant (241).

The 1,321 overflows from sources not otherwise identified show a different pattern inasmuch as they are found in areas with the following land uses: residential (536), commercial (275) and industrial (175).

TABLE IV-C—SUMMARY OF NUMBER AND PERCENT OF ALL REPORTED OVERFLOWS BY LAND USE IN VICINITY OF OVERFLOW POINTS

Land Use	Combined Sewers		Treatment Plant		Pumping Stations		Not Otherwise Identified		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Agriculture	207	1.5	97	.7	152	1.1	38	0.3	494	3.6
Recreation	1,474	10.6	37	0.3	104	.7	124	0.9	1,739	12.5
Residential	3,261	23.2	75	0.5	410	2.9	536	3.9	4,282	30.5
Industrial	3,454	24.7	218	1.6	290	2.1	175	1.3	4,137	29.7
Vacant	806	5.7	135	1.0	241	1.7	95	0.7	1,277	9.1
Commercial	1,303	9.3	28	0.2	82	0.6	275	2.0	1,688	12.1
Not Otherwise Identified	196	1.4	25	0.2	40	0.3	78	0.6	339	2.5
Total	10,701	76.4	615	4.5	1,319	9.4	132	9.7	13,956	100

Table IV-D summarizes the land use information by the number of jurisdictions reporting overflows. There were 483 jurisdictions with combined sewer overflows, 363 with treatment plant bypasses, 297 with pumping station bypasses and 54 with overflows from not otherwise identified sources. Of those reporting overflows from combined sewers, 226 jurisdictions indicated that residential land is located in the vicinity of the overflow point, followed closely by 192 jurisdictions with overflows in the vicinity of industrial land.

Highest Water Use in Vicinity of Overflow Points

The highest water use in the vicinity of the overflow points probably is a more critical consideration than land use. Table IV-E and Figure VII presents a summary of the present highest water use at the vicinity of overflow points as reported by the persons interviewed. Detailed information on water uses in the general locality of the overflow points,

FIG. VI. NUMBER OF OVERFLOWS TO VARIOUS TYPES OF LAND USE IN IMMEDIATE VICINITY BY SOURCE OF OVERFLOW

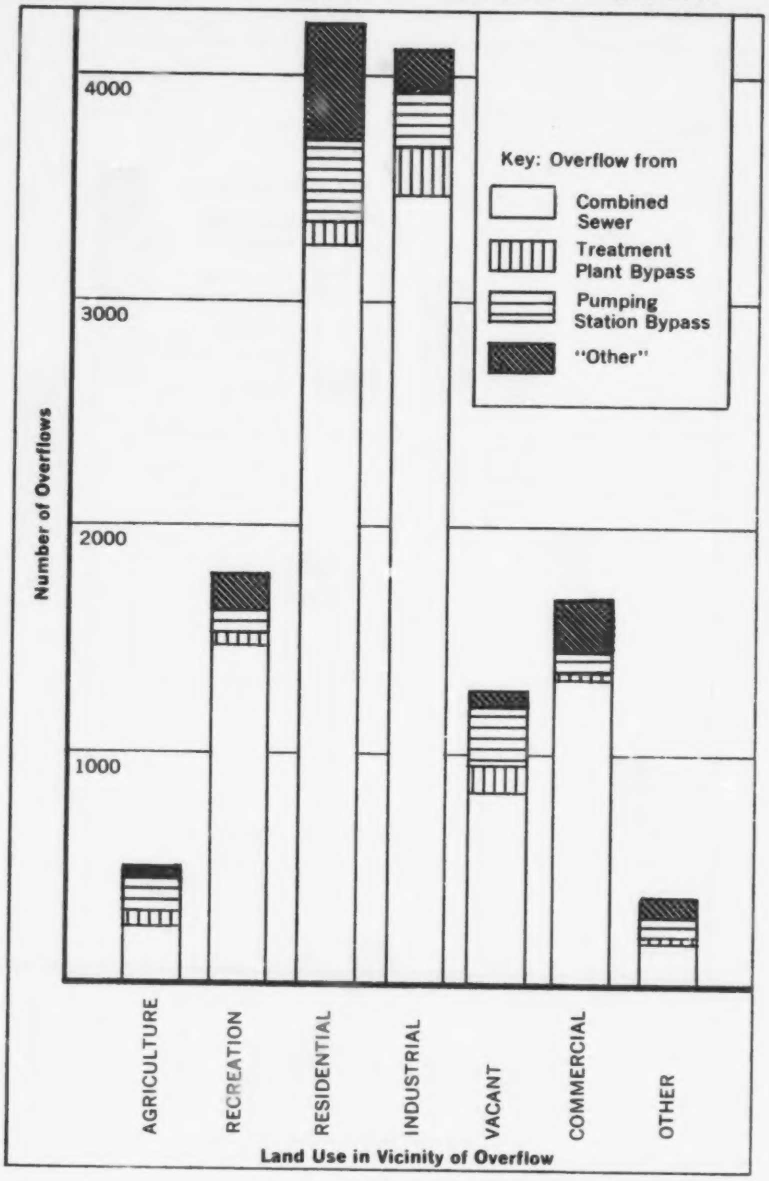


FIG. VII. NUMBER OF OVERFLOWS BY HIGHEST USE OF RECEIVING WATERS IN VICINITY OF OVERFLOW BY SOURCE OF OVERFLOW.

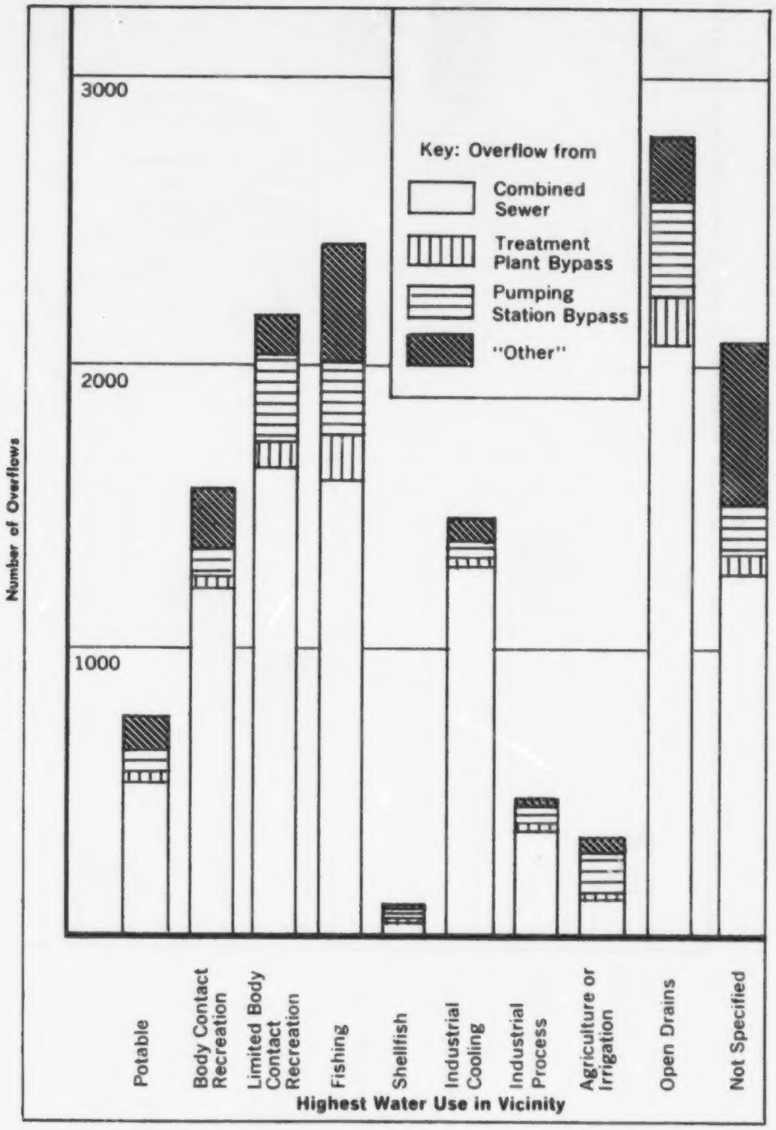


TABLE IV-D—SUMMARY OF NUMBER AND PERCENT OF ALL JURISDICTIONS REPORTING SOURCES OF OVERFLOW IN VICINITY OF DIFFERENT TYPES OF LAND USE

Land Use	Combined Sewers		Treatment Plant		Pumping Station		Not Otherwise Identified	
	No. of Responses	% of Total	No. of Responses	% of Total	No. of Responses	% of Total	No. of Responses	% of Total
Agriculture	68	14	81	22	45	15	7	13
Recreation	111	23	29	8	50	17	6	11
Residential	226	47	43	12	114	39	25	46
Industrial	192	39	123	34	103	35	22	40
Vacant	128	26	100	27	73	25	12	22
Commercial	130	27	19	5	44	15	11	20
Other	19	4	15	4	10	3	7	13
Total Reporting Jurisdictions	483	—	363	—	297	—	54	—

NOTE: Jurisdictions gave multiple responses.

by drainage basins, is included in Appendix J. Respondents, in all cases, did not answer each question fully; therefore, the number of overflows from each source varies slightly. The persons interviewed reported the highest water use, in the vicinity of 10,143 combined sewer overflow points. Open drains, for the transport of wastes, were the predominant use reported in 15 percent (2,086) of the cases. The number of other major water uses reported at overflow points are listed as follows: limited body contact recreation 11.8 percent (1,643) and fishing 11.5 percent (1,595).

For all 13,907 reported overflows, open drains accounted for 19.8 percent (2,762) of the total. In many instances these open drains are normally dry but ultimately connect to other receiving waters. Obviously sewage discharged to dry runs on an intermittent basis can create troublesome conditions by leaving a growing deposit of sewage solids. In only 5 percent of the cases was the receiving water in the vicinity of overflow points used as a source of potable water supply. However, in many instances, receiving waters will be a source of potable supplies at locations more distant from the overflow points.

TABLE IV-E—SUMMARY OF NUMBER AND PERCENT OF ALL REPORTED OVERFLOWS BY PRESENT HIGHEST WATER USE IN VICINITY OF OVERFLOW POINTS

	Combined		Sewage Treatment By Pass		Pumping Station By Pass		Not Otherwise Identified		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Potable Water Source	514	3.7	26	0.2	70	0.5	88	0.6	698	5.0
Body Contact Recreation	1,205	8.7	40	0.3	103	0.7	229	1.7	1,577	11.4
Limited Body Contact Recreation	1,643	11.8	92	0.7	287	2.1	119	0.9	2,141	15.5
Fishing	1,595	11.5	167	1.2	245	1.8	412	2.9	2,419	17.4
Shellfish	44	0.3	3	—	8	0.1	3	—	58	0.4
Industrial Cooling	1,300	9.4	24	0.2	59	0.4	66	0.5	1,449	10.5
Industrial Process	373	2.7	17	0.1	35	0.2	6	—	431	3.0
Agriculture or Irrigation	108	0.8	33	0.2	126	0.9	34	0.2	301	2.1
Open Drains (Transport of Wastes)	2,086	15.0	141	1.0	356	2.5	179	1.3	2,762	19.8
Not Specified	1,275	9.2	51	0.4	197	1.4	548	3.9	2,071	14.9
Total	10,143	73.1	594	4.3	1,486	10.6	1,684	12.0	13,907	100.0

Table IV-F is a summary of the number of jurisdictions which reported the present highest water use in the vicinity of overflows. A total of 618 jurisdictions reported on overflows from combined sewers, 407 from treatment plant bypasses, 373 from pumping station bypasses, and 71 from not otherwise identified sources. In all but the last category, fishing was the most prevalent present highest water use. This was followed by limited body contact recreation and open drains, used for the transport of wastes, as the next most common uses of water in the vicinity of overflow points.

TABLE IV-F—SUMMARY OF NUMBER AND PERCENT OF ALL JURISDICTIONS REPORTING OVERFLOW SOURCE AND HIGHEST WATER USE IN VICINITY OF OVERFLOW POINTS

Water Use	Combined Sewers		Treatment Plant		Pumping Station		Not Otherwise Identified	
	No. of Responses	% of Total	No. of Responses	% of Total	No. of Responses	% of Total	No. of Responses	% of Total
Potable Water Source	31	5	20	3	18	3	4	1
Body Contact	46	7	32	5	29	4	3	—
Limited Body Contact	108	17	73	11	69	11	11	2
Fishing	139	22	124	19	83	13	15	2
Shellfish	5	1	3	—	4	1	2	—
Industrial Cooling	43	7	20	3	21	3	3	1
Industrial Process Water	29	4	16	3	11	2	2	—
Agriculture or Irrigation	28	4	25	4	15	2	3	—
Open Drains	103	16	50	8	79	12	16	2
Not Specified	86	13	44	7	44	7	12	2
Total Reporting	618	—	407	—	373	—	71	—

NOTE: Jurisdictions gave multiple responses.

Types of Receiving Waters

The study shows that about 65 percent of all combined sewer overflow structures discharge to flowing streams. Of these, 73 percent overflow to streams that can provide dilution ratios greater than 10 to 1, and 51 percent flow into streams providing dilution ratios greater than 100 to 1. This may minimize the damaging effect of the added pollution, assuming that the receiving waters are not already so badly polluted from up-stream discharges that they cannot receive even this small additional load.

A dilution ratio is the ratio of the volume of the receiving water to the volume of the overflow or discharge. Thus, if a stream is flowing at the rate of 1,000 cubic feet per second and receives overflow wastes at the rate of 10 cubic feet per second, the dilution ratio is 100 to 1. The dilution ratio does not reflect the ability of a stream to assimilate pollution as this is influenced by such variables as season of the year, water temperature, rate of flow and other factors. However, it does give an indication of the relative size of the receiving body compared to the overflows it receives. The larger the dilution ratio the less likely it is that an individual overflow will create a serious problem.

The dilution ratios contained in the tables and discussed above are objective figures and are intended to generally categorize overflow situations and are not definitive with regard to individual cases.

Table IV-G and Figure VIII present a summary of all reported overflows by nature of receiving waters. Of the 14,760 overflow points, 10,434 were reported from combined sewers, 527 from treatment plant bypasses, 1,406 from pumping stations and 2,393 from not otherwise identified sources.

Tables detailing, by drainage basins, the nature of receiving waters from each source of overflow are contained in Appendix J.

FIG. VIII. NUMBER OF OVERFLOWS BY NATURE OF RECEIVING WATERS IN VICINITY OF OVERFLOW BY SOURCE OF OVERFLOW

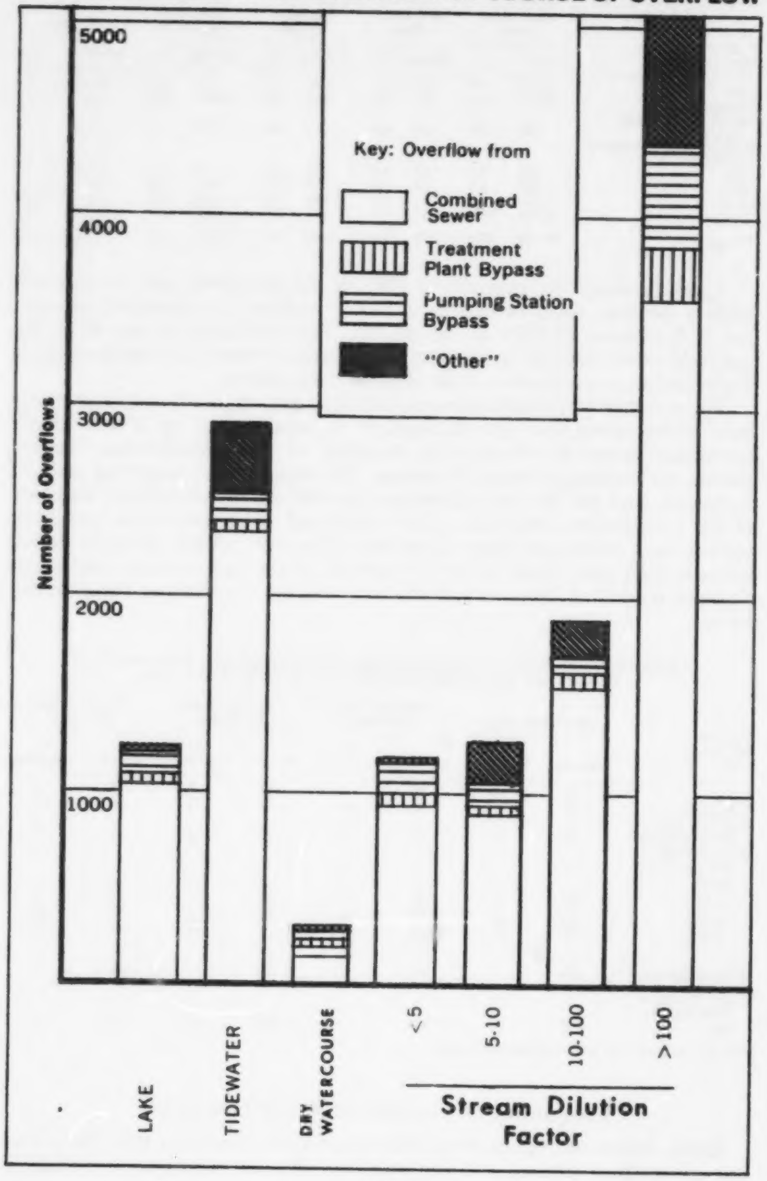


TABLE IV-G—SUMMARY OF NUMBER AND PERCENT OF ALL REPORTED OVERFLOWS BY NATURE OF RECEIVING WATERS IN VICINITY OF OVERFLOW POINTS

Type of Receiving Water	Combined Sewer		Treatment Plant		Pumping Station		Not Otherwise Identified		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Lake	1,031	7.0	33	0.2	77	0.5	24	0.2	1,165	7.9
Tidewater	2,325	15.8	52	0.4	162	1.1	1,388	9.4	3,927	26.7
Normally Dry Water Course	130	0.9	28	0.2	86	0.6	4	—	248	1.7
Streams With a Dilution Factor of										
<5	930	6.3	67	0.5	131	0.9	4	—	1,132	7.7
5–10	904	6.1	34	0.2	224	1.5	107	0.7	1,269	8.5
10–100	1,550	10.5	71	0.5	195	1.3	95	0.6	1,911	12.9
>100	3,564	24.2	242	1.6	531	3.6	771	5.2	5,108	34.6
Total	10,434	70.8	527	3.6	1,406	9.5	2,393	16.1	14,760	100.0

Approximately 35 percent (5,108) of all overflows are to streams with a dilution ratio in excess of 100. Overflows to tidewater account for 26.7 percent (3,927) of the points. The tendency for much of the nation's urban growth to develop along large rivers or favorable coastal areas probably accounts for the figures cited above.

The number of jurisdictions reporting on the type of receiving water into which overflows are discharged is summarized in Table IV-H. Combined sewer overflows were reported by 459 jurisdictions, 359 reported on treatment-plant bypasses, 288 reported on pumping station bypasses, and 56 for not otherwise identified sources. About one-half of the jurisdictions responding had combined sewer overflows, pumping station and treatment plant bypasses to streams with a dilution factor greater than 100. From 11 to 14 percent of the jurisdictions had overflows to tidewater from each of the four sources of pollution listed in the table.

TABLE IV-H—SUMMARY OF NUMBER AND PERCENT OF ALL JURISDICTIONS REPORTING OVERFLOW SOURCE AND RECEIVING WATERS

Type of Receiving Water	Combined Sewer		Treatment Plant By-Passes		Pumping Station By-Passes		Not Otherwise Identified	
	Number	% Reporting	Number	% Reporting	Number	% Reporting	Number	% Reporting
Lake	36	8	21	6	17	6	4	7
Tidewater	52	11	52	14	37	13	7	12
Normally Dry Water Course	20	4	7	2	26	9	1	2
Streams With a Dilution Factor of								
>5	53	11	39	11	40	14	3	5
5–10	47	10	26	7	34	12	5	9
10–100	102	22	56	16	66	23	16	28
<100	234	51	192	53	138	48	34	5
Total of Column	544		393		358		70	
Total Jurisdictions Reporting	459	—	359	—	288	—	56	—

NOTE: Jurisdictions gave multiple responses.

Frequency of Combined Sewer Overflows

Data, based on replies from 246 respondents, indicate that the number of overflow events, and the duration of such overflows, are smaller for combined sewers than the discharge events from separate storm sewers. Table IV-I shows this relationship:

TABLE IV-I—COMPARISON OF COMBINED SEWER OVERFLOWS AND SEPARATE STORM SEWER DISCHARGES

	Number Reporting	Average Number of Events per Year	Average Duration of Each Event in Hours
Combined sewer overflows	246	28	5
Separate storm sewer discharges	142	84	7

Ninety-eight jurisdictions or 15 percent reported continuous combined sewer overflows, attributing this to overloaded collector sewers or lack of a water plant.

These data show that regulatory devices on combined sewer overflow structures reduce the number of overflow events and their duration by transporting water from minor storms to the treatment plants. In contrast, separate storm sewers discharge all flows from all storms directly to receiving streams. Although storm water is generally polluted to some degree, it does not contain sanitary sewage.

Several communities reported bypassing most flow during periods of storm runoff. Treatment plants, they advised, were inadequate, and they did not want to subject them to overloads of grit or debris.

SUMMARY

To summarize, this portion of the study shows that:

1. Ninety percent of the overflows are in basins 1, 2, 5, 6, 7, 8, all contiguous and in the Northeast quadrant of the nation. The problem is less common in basins 10 through 16, the Southwest and West portions of the nation. Nearly 70 percent of the overflow points are in sewer systems, rather than at treatment plants and pumping stations.

2. Overflow points were more frequently reported in the vicinity of land used for industrial, residential, recreational and commercial purposes in that order. All could suffer both economically and esthetically by further pollution of streams abutting land used for such purposes. The study did not attempt to place a value on the loss, however, information included in Appendix K indicates there may be a loss of value which could be ascertained.

3. The most frequent water use in the vicinity of overflow points is that of open drains that normally are used for the purpose of transporting waste water to receiving streams. Fishing and limited body-contact recreation also rank high. In 5 percent of the cases the receiving stream in the general vicinity of the overflow point are used as sources of potable water supply.

4. When the overflows go to flowing streams, and they do in 64 percent of the cases, the dilution factors are relatively high. More than half reported dilution ratios of more than 100 to 1; and nearly three-fourths, greater than 10 to 1.

5. The survey also indicates that overflows occur an average of 28 times per year, and each overflow event lasts for an average of five hours.

SECTION V

FLOODING PROBLEMS RELATED TO COMBINED SEWER SYSTEMS

Questions Covered by the Survey

Sewer surcharges and local flooding effects

Relationships between surcharges and floodings, and population groups and drainage basin

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SECTION V

FLOODING PROBLEMS RELATED TO COMBINED SEWERS

Basement flooding is undoubtedly the most annoying problem created by the overloading of combined sewers. Both combined sewers and separate storm sewers are designed on the basis of the expected frequency, duration, and intensity of storms. Obviously, if a rainfall greater than that for which the system is designed occurs, the sewers will not be able to carry away runoff fast enough to prevent local flooding. During such periods, household and commercial connections to the combined sewer can be expected to back up because of the surcharge caused by the storm water. This creates nuisances, causes property damage, and poses health problems.

A total of 382 respondents reported design data for anticipated storms that will flow into their sewer systems. Of these, the average annual precipitation fell in these ranges:

Jurisdictions		Average Annual Rainfall
No.	%	
67	17	Less than 10 inches
39	10	10-20 inches
26	7	20-30 inches
156	41	30-40 inches
94	25	Over 40 inches
382	100	

The reported data indicate that the designers expect storms that will exceed the capacities of their storm and combined sewers at periods ranging from once every five years to once every 25 years. The average expectation of a storm that would exceed sewer capacity ranged from eight years, in municipalities receiving less than 10 inches of rain per year, to 13 years for those expecting over 40 inches per year. The survey showed that storm runoff in communities reporting, on the average, exceed the design capacity of the sewer, about once every 10 years. The design year storm is a statistical average and does not indicate the actual storm intervals.

Obviously, if such flooding occurred only once every decade, the problem would probably not be greater than design expectation. Unfortunately, flooding normally occurs at more frequent intervals at some points in the system. This may be due to many factors, including piecemeal development practices without providing sewer capacities to meet urban growth patterns.

Sewer surcharging and flooding of local community areas and individual properties bring the problem of sewer design, construction, and operation to the attention of the public served by all types of sewer facilities. The problem of overflows and discharges into watercourses is of more remote or detached effect on individual life and comfort than the flooding of streets, underpasses and basements in the community itself. Flooding experiences are often followed by public demand for local sewer improvements; combined sewer overflows in nearby watercourses seldom evoke equal public concern and protest.

Yet, these adverse local conditions are specifically related to the overflow problem. The same storm events which produce flooding in the community affect the amount and duration of overflows. Therefore, information on this local flooding problem was collected and evaluated as part of the study.

The reports of these conditions in surveyed communities—basement flooding, manhole overflow, underpass flooding and other conditions—are summarized in Table V-A, by drainage basin. The number of respondents indicating whether each type of flooding occurred varied. A total of 564 answered the question relating to basement flooding; manhole overflows, 539; underpass flooding, 508, and other types of flooding, 231. Of those responding to each, 69 percent indicated that basement flooding was a problem, 44 percent had problems with manhole overflows; 22 percent had underpass flooding, and 40 percent reported problems resulting from other types of flooding. Of the combined total of 1,842 answers received to the four questions of whether each type of flooding occurred, 45.5 percent replied to the affirmative.

TABLE V-A—NUMBER AND PERCENT OF JURISDICTIONS REPORTING FLOODING BY TYPE OF PROBLEM AND BY DRAINAGE BASIN

	Basement Flooding		Manhole Overflows		Underpass Flooding		Other Flooding	
Drainage Basin No.	No. Reporting	% Reporting Yes	No. Reporting	% Reporting Yes	No. Reporting	% Reporting Yes	No. Reporting	% Reporting Yes
1	116	56	112	42	102	24	47	31
2	47	68	45	44	38	21	13	38
3	6	50	7	85	7	57	0	0
4	0	0	1	100	0	0	0	0
5	119	69	118	44	112	20	41	24
6	32	81	31	32	32	37	16	43
7	92	81	84	50	85	24	46	50
8	81	76	74	32	69	15	27	33
9	22	77	19	57	20	30	8	87
10	2	50	2	100	2	50	1	100
11	2	100	2	100	1	0	2	50
12	3	33	3	66	2	0	1	0
13	32	53	32	46	30	3	20	55
14	3	66	3	66	3	66	3	0
15	3	66	3	66	3	0	2	50
16	4	50	3	0	2	0	4	100
Total	564	—	539	—	508	—	231	—
Average	—	69	—	44	—	22	—	40

To determine the effect of community size on the extent of the flooding problem, the data were summarized nationally, by population groups—Table V-B. Basement and underpass flooding show a definite relation to community population while manhole overflows and other conditions appear to be independent of community size.

Basement and underpass flooding and manhole overflows were reported less frequently in communities of less than 25,000 population; however, the pattern in the under and over 25,000 population groups is different. For basement flooding, the percentage of "yes" responses from communities in the less than 25,000 population groups was essentially the same for all groups—average 60 percent—and the same uniformity was shown by the over 25,000 groups—average 79 percent. For underpass flooding four population groups are indicated as follows:

(1) Less than 1,000: 1 "Yes" response for the 7 communities.
(2) Over 1,000 and less than 25,000: "Yes" replies for 21 of 232 communities, or 9 percent.
(3) Over 25,000 and less than 500,000: "Yes" replies for 81 of 238 responses, or 34 percent.
(4) Over 500,000: "Yes" replies for 11 of 21 responses, or 52 percent.

The apparent regional differences for basement flooding and manhole overflow were evaluated in more detail by consolidating the reports into three regional groups 1-4, 5-9 and 10-16. These summaries are presented in Table V-B. Throughout the population groups the percentage of "yes" replies is higher for the central regions (5 through 9) than for either of the other groups which are primarily coastal states. Consolidating the first and third regional groups into a single coastal group from the standpoint of the number of returns from the coast states—also shows that the central regions reported basement flooding as a problem to a significantly higher degree than other regions.

A similar regional grouping for manhole overflow replies verifies the slightly lower frequency of this problem in the central states. However, this difference does not appear to be significant.

TABLE V-B—LOCAL FLOODING BY POPULATION GROUP IN THE UNITED STATES

Percent "Yes" Replies of Those Responding to Question

	0-500	501-1000	1001-5000	5,000-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
Basement	0	60	53	65	61	84	75	73	85	64
Manhole	0	0	35	32	42	54	53	54	45	44
Underpass	0	16	7	9	9	25	31	53	52	22
Other	0	0	21	33	43	52	45	56	50	40
Drainage Basins	Percent "Yes" Replies for Basement Flooding of Those Responding to Question									
1-4	0	50	52	44	48	85	54	41	85	59
5-9	0	67	62	79	66	88	86	90	83	76
10-16	—	—	26	50	64	43	72	60	100	55
1-4 & 10-16	—	50	47	45	53	78	58	58	89	58
Drainage Basins	Percent "Yes" Replies for Manhole Overflow of Those Responding to Question									
1-4	0	0	63	76	43	58	50	41	66	55
5-9	0	0	35	37	40	54	51	46	33	42
10-16	—	—	33	43	54	62	80	62	50	54
1-4 & 10-16	50	0	36	44	47	59	58	59	60	48

Tables V-C and V-D give an overall indication of the effects of basement and underpass flooding on an annual basis in the various population groups, as reported by a small group of communities in a special survey:

Data presented in these two tables give an insight into the extent of the local flooding problem within a community. When over 10 percent of the dwelling units in 22 communities are affected by basement flooding, the drainage problem becomes one of major importance. Likewise, when 27 percent of the underpasses are affected there is reason to believe

TABLE V-C—BASEMENT FLOODING

No. of Communities Reporting	Population Groups	Total Dwelling Units Affected	% of Dwelling Units Affected	Total Dwelling Units[1]
9	1,001-5,000	1,190	31	3,860
11	5,001-10,000	1,387	7	19,493
4	10,000-25,000	485	4	12,700
11	25,001-50,000	14,506	21	49,460
2	50,001-100,000	4,467	12	35,930
32		22,037	16	141,433

[1] Calculated.

TABLE V-D—UNDERPASS FLOODING

No. of Communities Reporting	Population Groups	Underpasses Affected	% of Underpasses Affected	Total Underpasses[1]
3	1,001-5,000	5	42	12
3	5,001-10,000	4	100	4
1	10,001-25,000	1	100	1
3	25,001-50,000	4	17	23
9	50,001-100,000	25	35	72
1	100,001-500,000	1	4	25
1	500,001 & Over	2	10	20
21		42	27	157

[1] Calculated.

that a large number of motorists are subjected to a great deal of inconvenience and extra expense. Such deficiencies may also constitute problems for other residents of the community by preventing the delivery of milk and other supplies, and impairing the operation of emergency vehicles.

SECTION VI

COLLECTION SYSTEM REGULATORS

Questions Covered by the Survey

Number and types of regulator devices in service

Performance capabilities of various regulator devices

Overflow monitoring for quantity and quality of wastes discharged to receiving waters

Regulator maintenance and inspection schedules

Dry-weather overflows and infiltration problems

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SECTION VI

COLLECTION SYSTEM REGULATORS

A combined sewer system with an interceptor and a waste treatment plant requires devices to divert the waste water into the interceptor which, in turn, delivers the flow to the treatment plant.

The device, generally called a diversion works, is a structure housing equipment that:

1. Diverts waste water flows from the sewer to regulating and control mechanisms
2. Regulates or controls the quantity of waste water flow passing into the interceptor by means of an orifice, a leaping weir, or a float-operated valve or gate
3. Conveys waste water to the interceptor
4. Diverts excess flow to the receiving waters.

Principles and Operating Conditions

There are three distinct methods in use to perform this diversion. The controlling feature is actuated by:

1. The level or quantity of water in the combined sewer using leaping weirs, orifices, spillway weirs, or a pumping station
2. The level or quantity of water in the interceptor sewer using float-controlled gates or valves, or a pumping station
3. Remote controls, independent of the water level in either the sewer or the interceptor but related to it and controlled by automated gates or valves or by a pumping station.

Each method produces a different impact on the treatment plant and on the waters receiving the overflow or the effluent.

The first, governed by flow in the combined sewer, has little control over the amount of flow to the interceptor. It produces greater variations of flow in the interceptor and at the treatment plant. For this reason it does not take full advantage of the capacity of either and may not produce maximum benefit to the receiving waters.

The second, controlled by the flow in the interceptor, does exercise accurate control of the diverted flow up to the interceptor's maximum available capacity. This method produces more uniform conditions of flow in the interceptor and at the treatment plant, making maximum use of both and this minimizes the adverse impact on the receiving waters.

The third, actuated by remote control, governs the flows diverted to the interceptor, independent of the flow in either the sewer or the interceptor, by automated means interlocked electrically to the flow in both the sewer and the interceptor. This method provides flexibility in the total system of diversion allowing adjustments to be made quickly and easily from a central control point to compensate for changing circumstances. It produces a strictly controlled flow in the interceptor and at the treatment plant and thus affords equally good protection to the receiving waters.

There are nine specific types of regulators which function in accordance with the principles enumerated above. Each is briefly described as follows:

Float-Operated Gates

Float operated gate regulators are used where relatively large quantities of sewage are diverted. During normal flow, the sanitary sewage is diverted into the interceptor sewer through the regulator control or gate which is kept open by the float arrangement.

When storm runoff increases the flow, the level in the trunk sewer or in the interceptor sewer rises causing the water level in the float chamber to rise; the float raises and the gate is partially closed. The float drops when the storm runoff decreases, causing the gate to open and allowing flow to be diverted into the interceptor sewer.

Tipping-Gate Regulators

A tipping gate consists of a plate mounted on a pivot located below the centerline of the plate. The gate remains open during dry-weather flow permitting it to pass into the interceptor sewer.

During periods of wet-weather flow, the pressure on the upstream side of the gate above the pivot point causes the gate to close, reducing the orifice area, limiting the amount of combined sewage which can flow into the interceptor sewer.

The resulting loss of pressure causes a backup of flow with subsequent discharge over a diversion dam into the overflow conduit which flows into a receiving watercourse.

Hydraulic Cylinders

A gate valve operated by a hydraulic plunger and controlled by a venturi meter recording apparatus is actuated by a float. The sewage flows through an orifice in the bottom of the diversion chamber into a pipe upon which the hydraulic valve is constructed.

A float in the diversion chamber moves a vertical rod with tappets for opening and closing the hydraulic valve. A predetermined amount of discharge causes the closing tappet to trip the venturi register apparatus. A small valve admits water from a clean water main to the hydraulic cylinder and closes the main valve. When the discharge recedes to a predetermined level, the valve opens and causes the opening tappet to trip the mechanism to reverse the valve and open the gate valve.

Leaping Weirs

The leaping weir is a simple device, does not use mechanical equipment, and can be adjusted to meet actual flow conditions.

Dry-weather wastes flow at a velocity low enough to permit the dry-weather liquid to drop into an opening which discharges to the interceptor sewer. An increase in flow results in a velocity increase which causes part of the flow to leap across an opening and discharge to the combined sewer outlet. When the leaping weir is submerged, the opening operates as an orifice with changes in pressure resulting in variations in flow discharges.

Side or Spillway Weirs

Side weirs are constructed in the side of a sewer. When the elevation of the flow exceeds that of the weir, the excess flow is diverted to the receiving waters.

Perpendicular Weirs (Dam)

Diversion dams consisting of small dams placed across the trunk sewer are used to divert dry-weather flow to the interceptor sewer. Increase of flow due to wet-weather flow results in discharge over the crest of the dam and diversion of the flow is made to an overflow conduit. The quantity of diverted flow is determined by the level of flow above the crest of the dam as well as the length of the dam.

Manual or Automatic Valves

Manually operated stop gates may be operated as perpendicular weirs (dams) or as orifices. The elevation of the crest of the weir may be manually adjusted, thus modifying the amount of excessive flow diverted from the interceptor.

When operated as an orifice, the stop gates may control the amount of flow into the interceptor sewer as well as the quantity of excess diverted to the receiving stream.

Manually operated or automatically operated sluice gates may be operated as an orifice. Sluice gates may be used to control the diversion or flows to the interceptor sewer.

Siphons

Siphons present a means of regulating discharges in a sewer where little head is available for transfer to diversion discharge conduits. The siphon operates without mechanism and action can begin at a slight pressure differential and discharges at higher velocities than other devices such as weirs.

Siphons require venting to preclude blockage or air locking; obstruction can also occur. Odors may be vented to the atmosphere from the chamber in the siphon because of turbulence in the combined wastes.

Orifice or Drop-Inlet Regulators

Combined sewer flow passes through an orifice which is sized to accommodate the entire peak dry-weather flow and to deliver it to the interceptor sewer.

During storm conditions, the size of the orifice limits the amount of combined flow which may be discharged to the interceptor by the head on the orifice at the overflow point. Excess flows overflow the orifice into the diversion sewer leading to receiving waters.

Operating and Maintenance Problems

All types of regulators share one common operating problem—clogging. If there is any difference, the non-mechanical types, because of their simplicity, have less difficulty than mechanical and remote control regulators. To prevent clogging, maintenance men must make routine inspections of all regulating and control mechanisms. Mechanical and remote control regulators require more skilled maintenance. There are other maintenance problems peculiar to each type of regulator. These are briefly discussed below.

Float-Operated Gates: Inspections have shown many mechanical devices to be inoperable, abandoned or removed. It is possible that the sewage regulators and diversions were not functioning as designed and therefore did not meet their purpose due to changing conditions, operation and maintenance problems, failure of the mechanical device, or ordinary corrosion. In most cases, the design may not be simple and conducive to regular review and maintenance.

During storms, considerable amounts of debris, rags, and paper are conveyed through combined or storm sewers and blockage of float chamber openings or gate openings prevent proper operation. The inaccessibility of the units for inspection, operation and maintenance contribute to the problem of keeping such units in good operating condition.

If the float chambers are designed to receive flow from the trunk sewer in order to control the float position, trouble may be experienced from sediments. Sand, for example, may prevent the float from returning to the full open position of the regulator valve. This could result in the overflow of dry-weather sewage.

Testing of the devices is difficult because it would, necessarily, be required under storm conditions during which it would be hazardous for personnel to be on site. During dry weather, inspection of the gate seats and slides of the mechanism would require diversion of waste water.

Most float operated regulators, when inspected in recent years, have been found to be subjected to higher than design flows with accompanying higher velocities and turbulence that result in overflow during dry-weather flow. It takes only a small quantity of storm flow to result in such overflows.

Maintenance problems are more difficult in deep sewers with poor access through deep drop shaft manholes which lack safe and adequate means of ingress. Sometimes the only inspection entrance is through the sewer.

Tipping-Gate Regulators: Maintenance of the pivot point mechanism and careful checking of flow conditions is required. Wearing of the pivot mechanism and corrosion can lead to failure. At times, changes in dry-weather flow can result in diversion with little or no storm flow.

Hydraulic Cylinders: It is desirable to have the dry-weather, and most of the solid matter from wet-weather flows, pass through to the interceptor sewer prior to activation of the unit to keep the device from clogging.

Leaping Weirs: Organic matter can accumulate during low-flow conditions and thus result in decomposition. Depending upon the outlet design, blockage of the opening may occur. When dry-weather flow conditions change without the necessary modifications of the weir opening, dry-weather flow may be discharged.

Side or Spillway Weirs: Modification of the weir elevation due to blockage or damage may change the design diversion quantities. Increased dry-weather flows that exceed design capacities may also cause unforeseen overflows with little or no storm flows.

Perpendicular Weirs (Dam): Blockage or damage of the weir can modify the diverted flow which may occur during dry-weather flow conditions as stated above in case of other types of regulators. Clogging of the diversion orifice is also a common problem.

Manual or Automatic Valves: Stop gates are subject to blockage. It is difficult to change settings when the gates have been in position for a long period. Deposition of material upstream of the stop gate may modify hydraulic conditions and result in decay and odorous putrefaction. These valves may be placed in manholes, boxes, or other structures.

Slide and sluice gates may be used as orifices and may be manually or automatically operated. Continuous inspection and changing of the position of the gates is required as flows change.

Orifice or Drop-Inlet Regulators: These regulators may be considered as an orifice and have a limited hydraulic range of operation. Blockage or other opening modifications may result in unforeseen overflow. Adjustment of the unit is necessary with changes in dry-weather flow.

Siphons: Siphon operation is sensitive because of the minor variations in required discharge pressure. Changes in dry-weather flow could also result in premature diversion of flows. Blockage would, of course, make it impossible to achieve the desired results.

Local conditions may also affect the operation of regulators or flap gates which protect the sewer system from being flooded by high river stages or tides. As an example, many coastal areas reported that crabs often kept their regulators or gates from closing, thus allowing water to flow into the sewer system.

Number and Types of Regulators

Table VI-A shows the number and type of regulators in use in different drainage basins. The extent to which mechanical devices are used was reported as follows: floating gate, 1,356; tipping gate, 505; hydraulic cylinder, 68; and manual or automatic valves, 416. This amounts to 23 percent of the total of 10,025 regulators reported.

Of the non-mechanical types of regulators, the most common were: perpendicular weirs, accounting for 2,033 of the total, and side weirs reportedly used in 1,884 instances. A total of 3,803 regulators of other types were also reported to be in use.

The number of regulators in each drainage basin ranges from 20 to 100 percent of the total number of overflow points in the basin and from 77 to over 150 percent of the combined sewer overflow points. The number of regulators in a drainage basin may and does in some cases, exceed the number of combined sewer overflows because there are multiple regulators at some overflow structures and there are also regulators at pumping stations, treatment plants and other sources of overflow.

Drainage basins 1, and 5-8 have 82 percent of the total regulators reported. Floating gates are most prevalent in basins 1 and 5, with 428 and 420 installations respectively. This is in contrast to hydraulic cylinders where the majority are found in basins 2 and 9 with 23 and 24 installations respectively. In basin 4, floating gates were the only type of regulator reported in use.

TABLE VI-A—NUMBER OF COLLECTION SYSTEM REGULATORS BY TYPE AND DRAINAGE BASIN

Basin No.	Floating Gate	Tipping Gate	Hydraulic Cylinder	Leaping Weir	Side Weir	Perpendicular Weir	M/A[1] Valve	Drop Inlet	Not Otherwise Identified	Total	% of Total
1	428	29	3	95	580	524	92	194	74	2019	20.2
2	216	18	23	76	58	53	56	36	213	749	7.5
3	12	0	0	8	3	8	21	10	35	97	1.0
4	19	0	0	0	0	0	0	0	0	19	0.2
5	420	148	2	237	400	637	42	292	336	2514	25.1
6	60	0	0	465	78	220	59	169	10	1061	10.6
7	26	12	1	78	402	206	45	71	530	1371	13.7
8	159	283	9	32	180	186	61	165	152	1227	12.3
9	15	0	24	137	78	83	13	104	139	593	5.9
10	0	0	0	1	1	1	1	1	0	5	—
11	0	0	0	0	2	0	0	0	0	2	—
12	0	0	0	2	0	0	0	0	12	14	0.1
13	0	14	6	52	72	115	26	4	6	295	2.9
14	0	0	0	2	15	0	0	23	2	42	0.4
15	1	0	0	0	13	0	0	0	0	14	0.1
16	0	1	0	0	2	0	0	0	0	3	—
Total	1356	505	68	1185	1884	2033	416	1069	1509	10,025	100.0
% of Total	13	5	1	12	18	22	4	10	15	100%	—

[1] Manual or automatic.

Table VI-B reports the number of regulators in use by population group and drainage basin. Of the 10,025 regulators reported in this survey only three were listed as being used in communities of less than 1,000 population. Thirty-six (36) percent of all regulators are in jurisdictions of over 500,000 population.

TABLE VI-B—TOTAL NUMBER OF REGULATORS BY POPULATION GROUP AND DRAINAGE BASIN

Drainage Basin No.	0-500	501-1000	1001-5000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001 & Over	Total
1	—	—	64	50	143	255	307	572	628	2,019
2	—	3	51	63	13	17	276	82	244	749
3	—	—	—	—	8	—	47	24	18	97
4	—	—	—	—	—	—	—	19	—	19
5	—	—	95	81	269	398	426	644	601	2,514
6	—	—	47	91	69	43	62	233	516	1,061
7	—	—	35	59	74	177	98	240	688	1,371
8	—	—	35	79	50	244	133	255	431	1,227
9	—	—	8	22	12	2	11	166	372	593
10	—	—	—	—	—	—	5	—	—	5
11	—	—	1	—	1	—	—	—	—	2
12	—	—	—	—	—	—	7	5	2	14
13	—	—	13	25	27	30	16	134	50	295
14	—	—	—	—	—	—	—	2	40	42
15	—	—	—	6	—	—	8	—	—	14
16	—	—	1	—	—	—	2	—	—	3
Total		3	350	476	666	1,166	1,398	2,376	3,590	10,025

Table VI-C shows the distribution, by population group, of the 463 jurisdictions surveyed who reported having regulators. A total of 184, representing 40 percent of the jurisdictions using regulators, are in drainage basins 1 and 5. Basins 1, 2, and 5 through 9, contain 414 or 90 percent of the jurisdictions which reported the use of regulators.

TABLE VI-C—NUMBER OF JURISDICTIONS USING REGULATORS BY POPULATION GROUP AND DRAINAGE BASIN

Drainage Basin No.	0-500	501-1000	1001-5000	5001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001-500,000	500,001-& Over	Total
1		—	7	7	10	18	11	17	4	74
2	—	1	11	7	3	3	7	4	3	39
3	—	—	—	—	1	—	2	2	1	6
4	—	—	—	—	—	—	—	1	—	1
5	—	—	20	20	24	23	13	6	4	110
6	—	—	4	7	7	4	4	5	1	32
7	—	—	11	14	9	20	8	7	3	72
8	—	—	11	7	9	12	10	15	3	67
9	—	—	4	4	2	1	3	3	3	20
10	—	—	—	—	—	—	3	—	—	3
11	—	—	1	—	1	—	—	—	—	2
12	—	—	—	—	—	—	1	1	1	3
13	—	—	2	6	8	6	2	2	1	27
14	—	—	—	—	—	—	—	1	2	3
15	—	—	—	1	—	—	1	—	—	2
16	—	—	1	—	—	—	1	—	—	2
Total	—	1	72	73	74	67	66	64	26	463

The average number of regulators per jurisdiction is reported in Table VI-D. As would be expected, the average number per jurisdiction increases with population size from 3.0 for the 501-1,000 group to 21.2 for the 50,001-100,000 group to a high of 138.0 for the over 500,001 group. The average for all jurisdictions reporting is 21.6 regulators per community. The highest number reported was 516 regulators per jurisdiction in the over 500,001 group in drainage basin 6. The highest average number of regulators in use per jurisdiction, by drainage basin, was in basin 6 with 33.2; followed by basin 9 with 29.7 and basin 1 with 28.3. The lowest number of regulators per community was reported in basin 11 where the average is only one per jurisdiction.

TABLE VI-D—AVERAGE NUMBER OF REGULATORS PER JURISDICTION BY POPULATION GROUP AND DRAINAGE BASIN

Drainage Basin No.	0-500	501-1000	1001-5000	5,001-10,000	10,001-25,000	25,001-50,000	50,001-100,000	100,001 500,000	500,001 & Over	Average
1	—	—	9.1	7.1	14.3	14.2	27.9	33.6	157.0	28.3
2	—	3.0	4.6	9.0	4.3	5.7	39.4	20.5	81.3	19.2
3	—	—	—	—	8.0	—	23.5	12.0	18.0	16.2
4	—	—	—	—	—	—	—	19.0	—	19.0
5	—	—	4.8	4.1	11.2	17.3	32.8	107.7	150.3	22.8
6	—	—	11.8	13.0	9.9	10.8	15.5	46.6	516.0	33.2
7	—	—	3.2	4.2	8.2	8.9	12.3	34.3	229.3	19.1
8	—	—	3.2	11.3	5.6	20.3	13.3	17.0	143.7	18.3
9	—	—	2.0	5.5	6.0	2.0	3.7	55.3	124.0	29.7
10	—	—	—	—	—	—	1.7	—	—	1.7
11	—	—	1.0	—	1.0	—	—	—	—	1.0
12	—	—	—	—	—	—	7.0	5.0	2.0	4.7
13	—	—	6.5	4.2	3.4	5.0	8.0	67.0	50.0	10.9
14	—	—	—	—	—	—	—	2.0	20.0	14.0
15	—	—	—	6.0	—	—	8.0	—	—	7.0
16	—	—	1.0	—	—	—	2.0	—	—	1.5
Average	—	3.0	4.8	6.5	9.0	13.4	21.2	37.2	138.0	21.6

One hundred seventy-three (173) jurisdictions reported their annual average costs of regulator maintenance. The data reported are summarized in Table VI-E with the average population and average number of regulators per community.

TABLE VI-E—NUMBER AND AVERAGE COST OF MAINTAINING REGULATORS BY POPULATION GROUP

Population Group	No. of Jurisdictions Reporting		Average Population of all Jurisdictions	Average No. of Regulators per Jurisdiction	Average Cost of Maint. per Jurisdiction	Maintenance Cost	
	Maint. Cost Data	Having Regu-lators				Avg./Capita	Avg./Regulator
500-1,000	0	1	899	3.00	$ —	$ —	$ —
1,001-5,000	17	72	2,987	3.50	225	.08	64.30
5,001-10,000	24	73	6,896	4.90	553	.08	88.50
10,001-25,000	27	74	16,111	6.80	1,250	.08	184.00
25,001-50,000	32	87	37,142	9.70	9,194	.25	1,055.00
50,001-100,000	28	66	68,544	15.40	15,813	.23	1,028.00
100,001-500,000	30	64	187,887	33.40	14,177	.07	425.00
500,001 & Over	15	26	1,298,535	133.00	52,561	.04	395.00
	173	463	78,206	22.00	$11,569	$ .15	$ 527.00

The above figures show that the cost of regulator maintenance varies from $0.04 per capita in very large jurisdictions to about $0.25 per capita in jurisdictions of medium size. The cost of maintenance per regulator also varies with the size of the jurisdiction. The average annual cost of maintenance per regulator amounted to $527. Note the unusually high maintenance costs reported for jurisdictions in the 25,001 to 100,000 population group. There does not seem to be any easy way to explain this. No pattern of costs for individual types of regulator was apparent. Not all communities reported information on each item, thus the total number of replies is not uniform.

Information on overflows and infiltration is presented, by drainage basin, in Table VI-F. It shows the number and percent of "yes" replies based on the number of jurisdictions in the basin. The results are summarized in Table VI-G.

TABLE VI-G—DRY-WEATHER OVERFLOWS AND INFILTRATION PROBLEMS

	Number Reporting					
	Yes		No		Don't Know	
	No.	%	No.	%	No.	%
Overflows						
Do they occur?	96	20	387	80	0	0
Due to troublesome regulators	48	48	50	50	2	2
Due to lack of sewer capacity	53	50	51	48	2	2
Infiltration						
Dry weather	85	14	511	83	16	3
Wet weather	331	53	262	42	29	5
Exceeds code or design limits	170	29	208	36	207	35

Overflow Monitoring and Regulator Maintenance

The survey disclosed no significant regional or population pattern in monitoring overflows or maintaining the regulators. Table VI-H shows

TABLE VI-F—REPORTS OF DRY-WEATHER OVERFLOWS AND INFILTRATION BY DRAINAGE BASIN

	Do Dry-Weather Overflows Occur?			Dry-Weather Overflows Result from:						Infiltration								
				Troublesome Regulators?			Insufficient Sewer Capacity?			Dry-Weather			Wet-Weather			Does Infiltration Exceed Building Code or Design Criteria?		
Drainage Basin No.	Replies "Yes"	Total Replies	% Yes	Replies "Yes"	Total Replies	% Yes	Replies "Yes"	Total Replies	% Yes	Replies "Yes"	Total Replies	% Yes	Replies "Yes"	Total Replies	% Yes	Replies "Yes"	Total Replies	% Yes
1	30	76	39	13	26	50	16	30	53	26	119	22	62	123	50	30	110	28
2	5	39	13	3	7	43	1	7	14	7	54	13	22	55	40	9	45	20
3	1	7	14	—	1	—	1	1	100	3	8	37	7	8	88	6	9	67
4	—	1	—	—	—	—	—	—	—	—	3	—	2	3	67	2	3	67
5	13	113	12	12	20	60	5	19	26	9	138	6	83	139	60	35	132	26
6	13	32	40	9	12	75	7	14	50	6	34	18	27	32	84	11	32	34
7	11	80	14	5	11	45	7	11	63	8	96	8	39	97	40	18	92	20
8	10	71	14	5	12	41	6	11	54	13	88	15	49	92	54	32	91	36
9	4	21	19	—	4	—	3	4	75	1	22	4	11	22	50	4	22	18
10	—	3	—	—	—	—	—	—	—	—	3	—	2	3	67	—	3	—
11	—	2	—	—	1	—	—	1	—	—	2	—	—	1	—	1	2	50
12	—	3	—	—	—	—	—	—	—	1	3	33	2	3	67	1	3	33
13	8	28	28	1	5	20	6	7	86	9	31	34	17	33	52	18	31	58
14	1	4	25	—	1	—	1	1	100	—	4	—	3	4	75	1	4	25
15	—	1	—	—	—	—	—	—	—	1	3	33	2	3	—	1	2	50
16	—	2	—	—	—	—	—	—	—	1	4	25	3	4	75	1	4	25
Total	96	483	20	48	100	48	53	106	50	85	612	14	331	622	53	170	585	29

that on a national basis only 11 percent have made studies of the volume of overflow and 10 percent the quality of the overflow.

This monitoring, in many cases, represents only momentary or "catch" sampling for quality determinations and only occasional metering for quantity estimates. Very few overflows have been monitored consistently over long periods. It is significant that only one in ten have taken steps to monitor the quantity and quality of overflows from combined sewers.

Table VI-H also shows the regulator inspection schedules reported. Inspection following a storm and weekly were the most frequent schedules reported. Regular maintenance was reported by 70 percent of those reporting.

Of the jurisdictions reporting, 20 percent indicate that some of their sewers overflow during dry-weather, when no overflows should occur. Roughly, half of these overflows are reportedly caused by troublesome regulators, and the remaining half, by lack of sewer capacity. Both indicate the need for corrective action in the system itself. These overflows occur most often in basins 1, 2, and 5 through 9, the northeast quadrant of the nation. Dry-weather overflows were also reported in drainage basins 13 and 14 on the West Coast.

On the other hand, infiltration in excess of design criteria seems to be widespread and follows no particular pattern. A total of 85 communities representing 14 percent of the total respondents indicated that infiltration is a problem in dry-weather. Much of this apparently is caused by a high ground water table. Wet-weather infiltration was reported as a problem by 331 jurisdictions representing 53 percent of those responding to this question. Twenty-nine (29) percent of those reporting indicated that infiltration exceeds code or design limits, 36 percent stated that it did not, and 35 percent replied that they did not know whether or not it exceeded such limits.

TABLE VI-H—OVERFLOW MONITORING AND REGULATOR INSPECTION SCHEDULES

A-Overflow Monitoring

	Number of Replies			
	Yes		No	
	No.	%	No.	%
Quantity of overflow monitored	61	11%	474	89%
Quality of overflow monitored	54	10%	482	90%
Reports available on overflow monitoring	49	10%	425	90%

B-Routine Regular Maintenance Reported

	Yes	No	Don't Know
Number	327	139	1
Percent	70	30	0

C-Regulator Inspection Schedules Reported
(Many communities gave more than one answer)

	Number	Percent[1]
Weekly	121	25
Bi-weekly	43	9
Monthly	68	14
After a storm	139	29
Other	108	23
No regular inspection	139	—

[1] Based on total reporting regular schedules.

SECTION VII

CONTROL AND/OR TREATMENT OF OVERFLOWS FROM COMBINED SEWER SYSTEMS

Questions Covered by the Survey

Number of control and/or treatment installations in use
Regional variations in control and/or treatment methods
Current plans for overflow control and/or treatment projects
Applicability of control and/or treatment methods

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SECTION VII

CONTROL AND/OR TREATMENT OF OVERFLOWS

One or more of the following methods may be employed to reduce the effects of overflows from combined sewers:

1. Sewer separation
2. Surface drainage area control
3. In-system storage
4. Off-system storage
5. Treatment processes

Sewer separation requires that two separate systems for waste removal be constructed. When sanitary sewage and industrial wastes are separated from storm flows, the sanitary flows can, with proper sewer capacity and treatment, be handled without overflow incidents. Thus, separation is a "preventive" measure.

When applied to existing combined-sewer systems, surface drainage area control methods retain or divert storm-water runoff prior to entry into the sewers. Basically, this practice alters the storm-water runoff flow pattern which results in either (1) diversion of flow directly to natural drainage courses or storage basins for subsequent use or (2) retention of storm water for reduction of runoff flow rates into combined sewers thus reducing the frequency and duration of overflows. For new construction, storage of storm water in this manner permits the use of smaller diameter sewers.

In-system storage uses the storage capacity of the sewer conduits themselves to retain the storm water, and deliver it to the treatment plant over whatever extended period that the system will permit. It will serve to prevent overflows from smaller storms. Often, simple relief conduits, and interconnecting branch sewers will increase the applicability and capabilities of this method. In-system control basically is a refinement of the in-system storage method. Storm patterns may not be uniform, consequently some sewers may flow full, while others may be receiving very little. A control system, which can be governed automatically, can divert flows to the unused parts of the system, thus increasing the space available for storage.

Off-system storage makes use of lagoons, if the topography is favorable, or large artificial storage basins constructed underground. With these, deposition of solids in the basins can be troublesome, but not sufficiently so to negate their use.

Treatment processes remove polluting material from the overflow or neutralize its effect by the use of such means as: screening; disinfection; sedimentation; chemical coagulation; or other methods, some of which are being explored through research supported in part by FWPCA demonstration grants.

Number of Control and/or Treatment Installations

Table VII-A shows that the predominant method of control is by installing separate sanitary sewers. The survey disclosed 1,775 such separation projects, or 77 percent of the reported control installations.

Over 85 percent of these are in basins 5, 7, 8 (upper midwest) and basin 13 (northwest). However, most of these represent small projects covering limited portions of combined systems.

Of the remaining 546 control and/or treatment measures reported, 35 percent are screening installations; 25 percent, in-system storage; 19 percent, automated regulators; 7 percent, disinfection; 4 percent, off-system storage; 3 percent, sedimentation; 2 percent, chemical treatment; and 4 percent, other.

Although large numbers and many types of control and/or treatment measures were reported, the number of jurisdictions indicating that such measures were used was relatively small. For instance, sewer separation projects were reported by 122 jurisdictions and 40 reported screening of overflows.

The nature and extent of all of the control and/or treatment methods reported was not defined. Most measures were of limited scope. For example, many of the in-system storage projects could be better classified as surface drainage area control measures. In-system storage has been accomplished in some cases by merely raising the height of perpendicular weirs.

TABLE VII-A—NUMBER OF INSTALLATIONS REPORTED BY TYPE FOR CONTROL AND/OR TREATMENT OF OVERFLOWS BY DRAINAGE BASIN

Basin No.	Screening	Disinfection	Sedimentation	In-System Storage	Off-System Storage	Chemical	Automated Regulators	Sewer Separation	Other	Total
1	41	5	—	2	1	1	—	45	—	95
2	7	8	3	5	—	—	—	35	—	58
3	3	1	1	2	—	—	—	36	1	44
4	—	—	—	—	—	—	—	3	—	3
5	22	2	8	2	5	5	37	243	1	325
6	24	2	1	2	—	—	11	31	5	76
7	5	10	1	15	8	—	—	558	8	605
8	36	4	2	105	6	2	13	190	8	366
9	43	1	1	—	—	—	4	18	—	67
10	1	1	—	—	—	—	—	—	—	2
11	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	1	—	1
13	10	4	1	5	2	1	—	525	—	548
14	—	—	—	—	—	—	40	54	—	94
15	—	—	—	—	—	—	—	36	—	36
16	1	—	—	—	—	—	—	—	—	1
Total	193	38	18	138	22	9	105	1775	23	2321
% of Sub-Total	35.0	7.0	3.3	25.3	4.0	2.0	19.2	—	4.2	100
Total No. of Jurisdictions Reporting	40	20	11	27	12	5	13	122	5	255

NOTE: Total includes separation; however % of sub-total excludes separation.

The data gathered concerning plans for control installations was not sufficient to justify a detailed regional tabulation. The limited information available is shown in Table VII-B.

The total number reporting is not large, and this may reduce the precision of some of the percentages. Yet, it is of significance that 72 percent are planning sewer separation projects. Of the remainder, "other" and automated regulators appear to be somewhat more popular.

In any case, the planned projects probably represent work that will cover only portions of the sewer system, rather than the complete system, and usually are planned to correct specific local problems.

TABLE VII-B—PLANS FOR CONTROL AND/OR TREATMENT OF OVERFLOWS

Type	Total No. Reporting	Percent of Total
Screening	3	1.3
Disinfection	8	3.4
Sedimentation	7	3.0
In-system storage	9	3.8
Off-system storage	6	2.5
Chemical	4	1.7
Automated regulator	12	5.1
Sewer Separation	169	72.0
Other	17	7.2
TOTAL	235	100.0

The interviewers solicited answers from the respondents on the applicability of present methods. This showed little or no well-defined regional pattern. A summary is presented in Table VII-C. This table has special significance. Of the total "yes" replies as to the feasibility of using different methods, 31 percent believe that sewer separations will be applicable in the future. Of these, 169 have current plans for this type of correction. Contrast the opinions on applicability to the plans reported in the previous table. Note particularly that only 31 percent indicated that separation is applicable, while 72 percent reported current plans for such projects. It is possible that in the future there will be fewer locations where sewer separation will be considered applicable and more locations where alternate methods, such as those listed above, will have to be used.

TABLE VII-C—OPINIONS ON APPLICABILITY OF PRESENT CONTROL AND/OR TREATMENT METHODS

Type	No. of Replies				% of Replies		
	Yes	No	Don't Know	% of Yes Answers	Yes	No	Don't Know
Screening	61	183	63	9	20	60	20
Disinfection	81	175	63	12	26	55	20
Sedimentation	58	194	66	8	19	61	20
In-system storage	45	216	58	7	14	68	18
Off-system storage	72	182	60	11	23	57	20
Chemical	30	206	73	4	10	67	24
Automated regulator	57	176	70	8	19	58	23
Sewer separation	213	7	16	31	90	3	7
Other	66	61	50	10	37	34	29
TOTAL	683	1400	519	100	26	54	20

Table VII-D shows a comparison of the existing, planned and applicable methods of control and/or treatment of overflows, on a percentage basis. The relative ranking in each of these categories in terms of utilization of process or methods is given in parenthesis.

This table clearly indicates that although now extensively used, sewer separation is not considered to be the only solution to the combined sewer overflow problem. Separate sewers can be placed most easily in new or lightly populated suburban areas. They are very difficult and expensive to install in more densely populated areas, and especially in commercial districts. Not only is the first cost high, but the inconvenience is great. In the case of commercial and some industrial areas, this inconvenience can be translated into substantial economic loss.

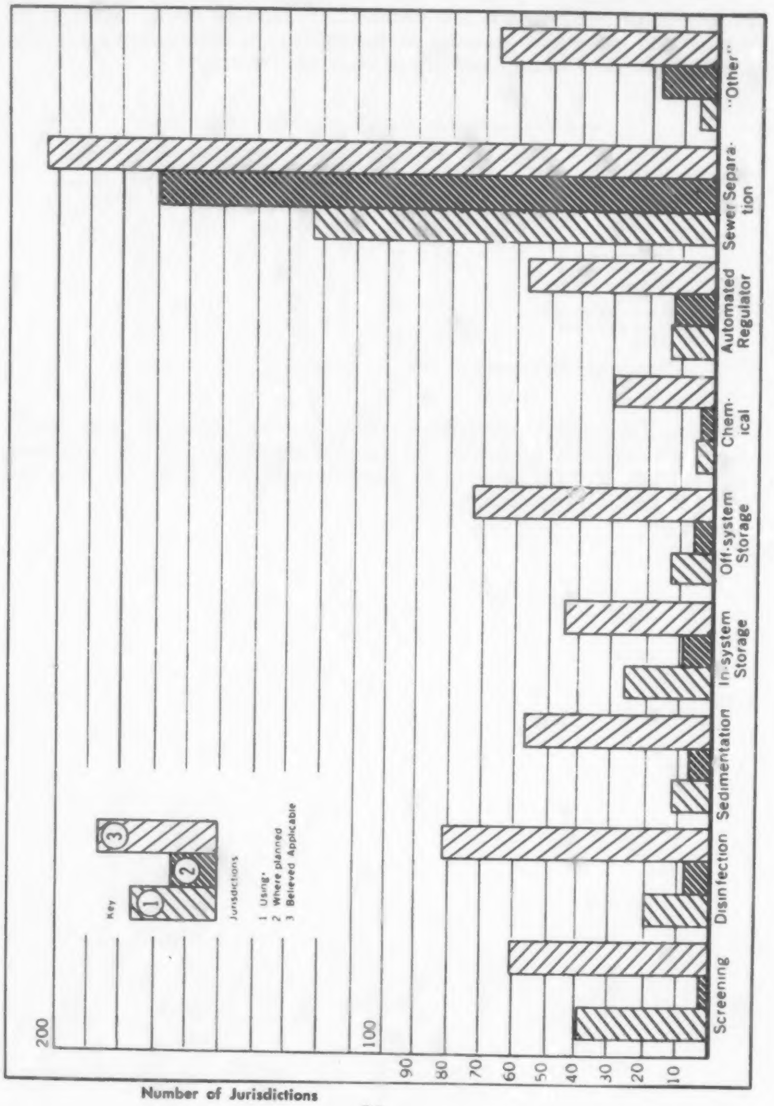
As a consequence, those who are responsible for developing practical programs for dealing with this problem are showing greater interest in disinfection, off-system storage, and screening. It is interesting to note the apparent lack of applicability of chemical treatment.

TABLE VII-D—CONTROL AND/OR TREATMENT METHODS

Type	Percentage of Total Jurisdictions Reporting and Ranking (Multiple Responses Received)		
	Existing	Planned	Applicability of Method
Screening	15.7% (2)	1% (9)	9% (5)
Disinfecting	7.9 (4)	3 (5)	12 (2)
Sedimentation	4.3 (7)	3 (6)	8 (6)
In-system storage	10.5 (3)	4 (4)	7 (8)
Off-system storage	4.7 (6)	3 (7)	11 (3)
Chemical	2.0 (8)	2 (8)	4 (9)
Automated regulator	5.1 (5)	5 (3)	8 (7)
Sewer separation	47.8 (1)	72 (1)	31 (1)
Other	2.0 (9)	7 (2)	10 (4)
Total Jurisdictions Reporting	255	235	683

Figure IX compares graphically the number of installations for treatment and control of overflows, the number of jurisdictions planning such construction and the number of jurisdictions which indicated that the method would be applicable.

FIG. IX. COMPARISON OF METHODS OF CONTROL AND/OR TREATMENT OF COMBINED SEWER OVERFLOWS: NUMBER OF JURISDICTIONS REPORTED USING, PLANNING CONSTRUCTION AND BELIEVING METHODS APPLICABLE.



SECTION VIII

WATER POLLUTION CONTROL PLANT PROCESSES, CAPACITIES, BYPASSING PRACTICES AND IMPROVEMENT PLANS

Questions Covered by the Survey

Number of treatment plant bypasses and locations

Treatment plant, flow and industrial wastes loadings

Average dry-weather and wet-weather flows and BOD removals

Capacity and type of treatment at present plants

Plans for plant additions in the next five years

Bypassing practices at plants due to maintenance work, breakdowns, excessive wet-weather flows and prevention of flood damage

Jurisdictional responsibility for treatment

SECTION VIII

WATER POLLUTION CONTROL PLANT PROCESSES, CAPACITIES, BYPASSING PRACTICES AND IMPROVEMENT PLANS

The ultimate purpose of combined sewer separation is to deliver the separated sanitary flow, including industrial wastes, to a water pollution control plant with adequate capacity and a satisfactory degree of treatment to produce an effluent that will not adversely affect the waters into which it is discharged.

It is of significance, therefore, to know the role which water pollution control plants play in the present diversion of a portion of the combined flows which are delivered to them. Theoretically, at least, it is an anomaly to provide interceptor sewer capacities to carry flows to a treatment plant under certain circumstances and then to permit a portion of this flow to be diverted to receiving waters at that point. This might be regarded as wasteful of interceptor capacity and of pumping station operations if a portion or all of the combined flow is pumped as part of interceptor transmission system operations.

There are several factors, however, which may make routine diversion of combined flows to watercourses at water pollution control plants proper and desirable rather than allowing these waste waters to overflow at points upstream from the plant. These include: (1) the ability to provide partial or primary treatment and disinfection for the diverted flows before they are discharged at the plant, and to then provide full treatment for the balance of the flow which is within the capacity of secondary or tertiary phases of treatment; and (2) bringing combined flows to the treatment plant because diversion at this point would have less deleterious effects on the water and land resources, or because the dilution flows might be higher at this downstream location than they would be at the upper reaches of the interceptor sewer system.

Bypassing does occur at water pollution control plants, not only from those works which receive combined sewage, but from those which handle so-called separate sanitary flows with their industrial wastes components. These diversions take place for various reasons, including: temporary reduction in plant capacity due to maintenance of all or parts of the plant facilities; breakdowns in equipment; inability of plants to handle flows beyond their limited hydraulic capacities; the necessity to protect plant facilities from inundation or flooding during high stages in the receiving waters; and the need to protect certain plant processes, such as the activated sludge process, against excessive flows which might impair treatment efficiencies long after the peak flows have subsided.

Since almost all plants have some means for bypassing all or a portion of the untreated or partially-processed flow, the interviewers obtained data from officials of those jurisdictions included in the study on such matters as:

1. The capacities of the plants and the types of treatment
2. Biochemical oxygen demand (BOD) loadings and their removals by the plants, including population equivalents of wastes

3. Average dry-weather and wet-weather flow
4. The frequency and reasons for bypassing
5. Plans for plant improvements, and the use of grants to aid in financing.

Treatment Plant Data

Table VIII-A summarizes pertinent data on the capacities of treatment plants. Ninety-one (91) percent of the population of all jurisdictions surveyed are served by sewerage systems with treatment plants. In basins 6, 11, and 12, the percentage is even higher—99 percent. However, it is important to realize that the water pollution control plants do not necessarily treat the wastes of the entire population of such communities.

A wide range of flows were reportedly used as the basis of designing present treatment plants. During dry weather periods, the expected waste-water flow ranged from a low 143 gallons per capita served per day in basin 3 to a high of 425 gallons for basin 15. The national average based on figures reported in this survey is 190 gallons per capita per day.

The expected wet-weather flows also varied widely, from 150 gallons in basin 6 to 575 in basin 14 and 15, with an average of 256 gallons per capita per day. The fact that in most of these basins the survey included so few jurisdictions suggests that peculiar local conditions probably account for these figures. Wet-weather flows equal or exceed plant capacities in six of the 16 basins. Nationally, the average wet-weather design flow was reported as being 80 percent of plant capacity.

Industrial Wastes

The discharge of industrial wastes is a source of serious pollution, equal to or greater than that which results from untreated municipal wastes discharges. Regulatory agencies insist that industries either treat their wastes or discharge them to some public system where they will be treated in combination with sanitary sewage. In increasing numbers of cases, industries find it financially to their advantage to use the latter method, even when they pay the public agency to receive and treat their wastes. In some instances, however, industrial wastes must be pretreated before they will be amenable to transportation and treatment, and acceptable by a public agency. In other cases, industrial wastes would not be suitable for joint handling with sewage.

Designers frequently find it convenient to illustrate the polluting effect of an industrial waste by calculating how many average people would produce a sewage flow having a "strength" or pollution load of equal magnitude. Sanitary engineers customarily refer to this as "population equivalent."

Data reported on industrial wastes as shown in Table VIII-B show a varying industrial load with the size of the municipality. The data disclose a regional pattern that shows the largest volumes of industrial waste-water to be in basins 7, 1, 5 and 9. It also shows that industrial wastes equal 69 percent of the normal sanitary pollution load, measured in terms of biochemical oxygen demand. For the 192 jurisdictions reporting, the industrial wastes population equivalent was 26,875,000.

TABLE VIII-A—SEWERED POPULATION, WATER POLLUTION CONTROL PLANT CAPACITY AND ACTUAL FLOWS IN COMMUNITIES SURVEYED BY DRAINAGE BASIN

Drainage Basin No.	Sewered Population with Treatment Plants (10^3)	Percent of Total Population of Surveyed Communities	Plant Capacity (MGD) (Total)	Plant Capacity (MGD) per 1000 Sewered Population (Gallons/person)	Plant Capacity (MGD) per 1000 Acres Sewered	Dry-Weather		Wet-Weather		
						Flow (MGD)	Gallons/Capita/Day	Flow (MGD)	Gallons Capita/Day	Flow as Percentage of Plant Capacity
1	12,994	87	4,100	316	5.6	1,877	144	2,642	204	64
2	5,150	93	1,313	255	4.1	819	159	871	169	66
3	919	82	169	184	1.0	131	143	197	214	117
4	138	96	46	334	1.9	25	181	47	340	102
5	5,051	85	1,953	387	3.1	939	186	1,476	292	75
6	2,390	99	527	221	2.0	467	196	359	150	68
7	6,994	97	2,805	401	4.3	2,322	332	2,637	377	94
8	5,723	94	2,273	397	4.0	1,528	267	2,377	416	104
9	3,525	97	539	154	1.3	251	—[1]	527	—[1]	98
10	204	97	44	216	0.8	21	103	46	226	104
11	26	99	4	154	0.6	5	192	6	231	150
12	1,199	99	82	68	0.4	21	—[1]	75	—[1]	92
13	759	45	319	420	1.6	168	222	287	378	90
14	1,095	78	630	575	5.6	212	194	313	286	50
15	40	32	23	575	2.3	17	425	23	575	100
16	0	0	0	—	—	0	—	0	—	—
Total	46,207	—	14,827	—	—	8,803	—	11,883	—	—
Average	—	91	—	321	38.6	—	190	—	256	80

[1] Note: Local conditions make these calculations not applicable.

TABLE VIII-B—INDUSTRIAL WASTES POPULATION EQUIVALENT OF JURISDICTIONS REPORTING BY POPULATION GROUP AND DRAINAGE BASIN

	Drainage Basin	Number Jurisdictions Reporting	Industrial Wastes Population Equivalent Reported (in 1000's)	Proportion of Industrial Waste Population Equivalent to Total Population of Reporting Jurisdictions
	1	47	4,798	0.40
	2	11	1,795	0.71
	3	6	615	0.65
	4	—	—	—
	5	29	3,366	1.14
	6	21	345	0.38
	7	31	9,121	0.83
	8	22	2,522	1.15
	9	10	2,897	0.89
	10	1	24	0.38
	11	—	—	—
	12	—	—	—
	13	21	768	0.51
	14	3	600	0.43
	15	—	—	—
	16	—	—	—
Total		202	26,873	

Population Group	Industrial Wastes Population Equivalent Reported (in 1000's)	Proportion of Industrial Waste Population Equivalent to Total Population of Reporting Jurisdictions
0-500	—	—
501-1000	—	—
1,001-5,000	76	1.31
5,001-10,000	324	1.55
10,001-25,000	1,393	1.76
25,001-50,000	1,358	0.98
50,001-100,000	2,182	0.94
100,001-500,000	5,322	0.96
Over 500,001	16,218	0.56
Total	26,873	0.69

Degree of Treatment Provided

The degree of treatment is in the process of being upgraded. Federal requirements for obtaining financial assistance, as well as regulations established by many states provide that the treatment remove at least 80 percent of the polluting material. Primary treatment cannot do this, and some type of secondary treatment is becoming mandatory. In some instances, a third stage of treatment may be required.

Table VIII-C shows that at the time of the survey, 197 or 31 percent of the municipalities with combined sewers had no treatment plant. However, 76 of these discharged their waste-water to other jurisdictions through regional arrangements. By omitting them, the survey shows that 22 percent of the municipalities provided no treatment; 42 percent, primary treatment; 35 percent, secondary treatment; and one percent, some type of third-stage treatment.

Several interesting regional relationships were revealed by the survey. For instance, basin 12 contains secondary treatment plants for all three of the jurisdictions surveyed. Basin 6 had the next highest percentage of jurisdictions with secondary treatment with 73 percent. Basin 1 had the lowest with only 10 percent of the jurisdictions reporting secondary treatment. Of all the 4 jurisdictions surveyed in basin 16 (Alaska), none reported any treatment facilities whatsoever. The next region of the country reporting the highest percent of jurisdictions having no treatment plants was basin 1 where 48 communities, representing 37 percent of the jurisdictions, indicated that no treatment facilities were available.

TABLE VIII-C—DEGREE OF TREATMENT PROVIDED BY DRAINAGE BASIN

Drainage Basin	No Treatment		Primary		Secondary		Tertiary		Jurisdictions Served By Others	
	Jurisdictions in Basin		Jurisdictions in Basin		Jurisdictions in Basin		Jurisdictions in Basin			
No.	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	48	37	57	44	13	10	—	—	10	9
2	17	30	23	40	16	28	—	—	1	2
3	3	33	2	22	4	45	—	—	—	—
4	1	33	1	33	1	33	—	—	—	—
5	26	18	56	39	49	35	—	—	11	8
6	—	—	6	18	25	73	1	3	3	6
7	9	9	28	28	38	39	3	3	21	21
8	8	8	34	36	23	24	—	—	29	32
9	1	4	6	26	14	61	2	9	—	—
10	—	—	1	33	2	67	—	—	—	—
11	—	—	1	50	1	50	—	—	—	—
12	—	—	—	—	3	100	—	—	—	—
13	3	9	20	61	8	24	1	3	1	3
14	—	—	4	100	—	—	—	—	—	—
15	1	33	—	—	1	33	1	33	—	—
16	4	100	—	—	—	—	—	—	—	—
Total	121	—	239	—	198	—	8	—	76	—
Average	—	19	—	37	—	31	—	1	—	12
% of Types of Treatment	—	—	53	—	45	—	2	—	—	—

Plant Bypassing Practices

Table VIII-D provides two significant sets of data. The first lists the number of hours that the operators bypass their plants. The second indicates the number of discharges of raw sewage from facilities not connected to the sewer systems.

Note that plants of the jurisdictions responding to this question are being bypassed an average of 507 hours per year per plant for various reasons excluding those listed as "other." This means that they are out of service 21 days or 5.5 percent of the time.

Including "other" reasons for bypassing would bring the average hours bypassed per year per plant to 842 or 35 days which would be about 10 percent of the time. In reviewing this data it must be remembered that only a limited number of jurisdictions reported on each item: It is believed that the lack of readily available information was the reason for many not answering, rather than the fact that there were no bypassing of flows. Some bypassing is usually necessary. For example, 89 jurisdictions reported an average of 89 hours of bypassing to accomplish routine maintenance, while 139 reported an average of 68 hours per year of bypassing due to mechanical breakdowns.

Wet-weather bypassing is the most prevalent as 197 jurisdictions reported an average of 350 hours per year. As previously mentioned, wet-weather bypassing may be necessary for a variety of reasons including insufficient capacity of the water pollution control plant. Among the other reasons reported by the jurisdictions surveyed were: (1) treatment plant not designed to handle grit and debris carried by storm flow thus requiring the bypassing of such flows to keep from having plant process interrupted, (2) high river stages which without excessive pumping do not permit operation of treatment plant, and (3) receiving stream flow of such magnitude that treatment is not deemed necessary by local officials.

The second portion of Table VIII-D, relating to other sanitary sewer discharges, discloses a concern over these deficiencies, since two-thirds of the 237 reporting jurisdictions have correctional plans. The greatest number of these deficiencies are in basins 1 and 8, representing nearly 70 percent of the total. Many of these sewer discharges result from the practice of not connecting to the interceptor the sewers in small areas along streams which require pumping to get the flows into the system. The sewers in these "residual" areas are thus left behind for later connection to the system serving the rest of the community. The process of eliminating these discharges is costly. One jurisdiction reported plans to buy the property rather than attempt to connect 10 residences to their sewer system.

Pumping stations that receive combined sewage are usually bypassed somewhat less frequently than are treatment plants. However, this can vary from one-tenth to twice the plant bypass hours.

TABLE VIII-D—HOURS OF TREATMENT PLANT BYPASS AND NUMBER OF OTHER SANITARY SEWER DISCHARGES BY DRAINAGE BASIN

	Annual Average Hours Plant Bypassed (By Cause)				Other Sanitary Sewer Discharges			
Basin No.	Maintenance	Breakdowns	Wet-Weather	Other	No. of Jurisdictions Reporting Such Discharges	No. of Locations	Jurisdictions with Correction Plans	% of Jurisdictions with Correction Plans
1	342	150	188	1,350	72	3,387	55	76
2	139	35	213	6	12	178	6	50
3	139	336	151	—	5	5	5	100
4	—	—	10	—	1	20	1	100
5	29	74	385	47	46	631	29	63
6	6	23	940	30	14	533	9	64
7	62	34	292	317	22	584	14	64
8	25	12	37	560	32	1,986	18	56
9	163	79	276	—	8	31	5	62
10	—	504	104	—	1	6	1	100
11	72	28	230	—	1	1	1	100
12	16	—	420	480	1	1	1	—
13	37	22	332	4	16	286	9	56
14	24	72	167	202	3	6	—	—
15	72	13	48	—	—	—	—	—
16	—	—	—	—	3	104	2	67
Total	—	—	—	—	237	7,759	156	—
Average	89	68	350	335	—	—	—	65
No. Jurisdictions Reporting	89	139	197	38	—	—	—	—

Financing Water Pollution Control Plant Expansion

During recent years, a number of grant-in-aid programs have been developed to ease the financial burden of water pollution control plant construction. Table VIII-E summarizes them and illustrates rather clearly that any municipality expecting to build a new plant or to enlarge its present one will look industriously for some type of outside financial help.

The classification in the table of "other" includes state grants and also assistance from such regional agencies as the Appalachian Development Commission.

TABLE VIII-E—PLANS FOR FINANCING TREATMENT PLANT EXPANSION BY DRAINAGE BASINS

	Additions Planned		Funds Available		Federal Funds to be Requested		Federal Agencies to Which Requests Have Been, or Will be, Made (Multiple responses were received)				
Basin No.	No.	%	No.	%	No.	%	FWPCA	HUD	EDA	FHA	Other
1	67	73	13	21	58	89	40	31	5	3	54
2	24	62	10	77	15	75	17	1	—	—	13
3	7	86	2	68	7	100	7	7	—	—	6
4	1	50	—	—	1	100	—	—	—	—	—
5	53	49	14	24	39	76	33	8	4	6	25
6	18	55	3	18	11	69	9	6	—	2	15
7	40	58	17	44	24	67	25	7	3	2	22
8	33	56	8	23	22	67	24	4	1	2	24
9	7	33	4	44	6	75	5	3	1	—	5
10	3	100	2	67	3	100	2	1	—	—	2
11	1	50	—	—	1	100	1	—	—	—	1
12	1	50	—	—	—	—	—	—	—	—	—
13	16	55	4	22	13	81	12	7	3	—	21
14	2	67	1	50	1	50	1	—	—	—	2
15	1	100	—	—	1	100	1	—	—	—	2
16	1	25	—	—	2	100	—	2	—	—	—
Total	275	—	78	—	204	—	177	77	17	15	192
Average	—	58	—	28	—	78	—	—	—	—	—

Key: FWPCA—Federal Water Pollution Control Administration; HUD—Department of Housing and Urban Development; EDA—Economic Development Administration; FHA—Farmers Home Administration.

The table indicates that 275 jurisdictions have plans for additions or basic construction of treatment plant facilities. Of these, only 78 have funds available or committed for the work planned, while 204 plan to ask for some form of grant-in-aid. The Federal Water Pollution Control Administration was the most often named of the Federal agencies from which aid would be requested.

Jurisdictional Responsibility for Treatment

The study explored the extent of jurisdictional arrangements to collect and dispose of waste-waters from neighboring communities, in recognition of the growing importance of the "split responsibility" trend as part of today's metropolitan complexes.

A total of 120 communities reported that they accept combined sewer discharges from other systems. These are generally larger, i.e. "central cities." Over 73 percent of those accepting combined sewer flows are in eight states—Massachusetts, New Jersey, New York, Pennsylvania, Indiana, Ohio, Illinois, and Michigan—all of which are classified as major industrial states and which contain the majority of the jurisdictions in the over 25,000 group (195 of the 308 survey jurisdictions).

The distribution of the 93 communities discharging to another system parallels that for communities accepting discharges, except that, in general, the population groups are somewhat lower.

SECTION IX

COST OF SEWER SEPARATION AND OTHER METHODS OF CONTROL AND/OR TREATMENT OF OVERFLOWS

Questions Covered by the Survey

Cost of complete and partial separation projects

Methods and costs of alternate methods of control and/or treatment of overflows

Projection of costs on a national basis

Comparison of cost estimates with other cost studies

Engineering studies of corrective actions for combined sewer overflows

Plans for financing construction of pollution abatement projects

SECTION IX

COST OF SEWER SEPARATION AND OTHER METHODS OF CONTROL AND/OR TREATMENT OF OVERFLOWS

Before corrective actions can be taken to minimize or eliminate combined sewer overflow problems, communities must make engineering studies and arrive at cost estimates which will indicate the most effective and economical projects for local conditions. Since there is an unavoidable time gap between planning and construction, the status of engineering investigations of such problems and projects can serve as an indication of the necessary actions that will eventually be taken to correct the overflow problem.

To provide this information for representative communities, the survey explored the status of studies to define any corrective actions and the estimated costs of such work; of cost estimates for complete sewer separation project; and of current plans for correcting problems stemming from overflows and the costs of such proposals.

The following data cover the information which the survey obtained on these questions.

Status of Studies and Cost Estimates for Corrective Actions

The information regarding the number of communities with studies, cost estimates, and corrective action planned is summarized in Table IX-A. The basis for the calculations of the various percent "yes" figures was different for studies and for cost estimate plans. The percent "yes" for engineering studies was based on the number of surveyed communities. "Unreported" communities were considered as "no" replies. The percent "yes" for cost estimates and community plans was determined on the basis of the number of communities with engineering studies.

TABLE IX-A—JURISDICTIONS REPORTING ENGINEERING STUDIES, COST ESTIMATES AND CORRECTIVE PLANS BY DRAINAGE BASIN

						Current Corrective Plans			
		Studies		Cost Estimates		Separation		Alternative	
Basin No.	Number of Communities Reporting	No. Yes	% Yes	No. Yes	% Yes	No. Yes	% Yes	No. Yes	% Yes
1	128	65	50	44	67	53	82	10	15
2	57	25	44	15	60	17	68	2	8
3	9	3	33	4	100	3	100	1	33
4	3	1	33	—	—	1	100	—	—
5	143	45	32	26	58	25	56	6	13
6	34	21	62	18	85	10	47	6	29
7	99	52	53	42	81	38	73	13	25
8	94	51	54	33	84	36	71	9	18
9	23	10	43	7	70	4	40	—	—
10	3	3	100	3	100	2	67	1	33
11	2	1	50	1	100	2	100	1	100
12	3	2	67	2	100	1	50	—	—
13	33	25	76	22	88	24	96	2	8
14	4	3	75	2	67	2	67	1	33
15	3	2	67	1	50	3	100	—	—
16	4	1	25	—	—	1	100	—	—
Total	641	310	48	220	71	222	71	52	17

Approximately one-half, or 310 jurisdictions, reported that engineering studies to correct pollution problems resulting from combined sewer overflows or storm water discharges had been completed. Many others reported that studies were currently under way or were about to be started. A total of 220 jurisdictions, representing 71 percent of those reporting studies, indicated that cost estimates for the necessary construction had been prepared.

Of the 274 jurisdictions with current plans to construct corrective facilities, 222 or approximately 71 percent of those with plans, indicate that they intend to undertake some degree of sewer separation. The remaining 52 plan to use some alternate means of correcting their overflow problem.

Information received as a result of the interviews was not considered sufficiently reliable to use for national projections of the cost of sewer separation. Therefore, the staff extracted costs for sewer separation from 126 engineering reports which had been submitted by the jurisdictions for which they had been prepared.

Forty-nine (49) states and the District of Columbia were grouped into seven geographic regions to help clarify and process the cost evaluation. Hawaii reported no combined sewers. These regions should not be confused with the drainage basins frequently referred to in this report. The regional groupings are listed as follows:

a) New England:
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont

b) Middle Atlantic:
Delaware, New Jersey, New York, and Pennsylvania

c) South Atlantic:
District of Columbia, Maryland, Virginia, and West Virginia

d) Southern:
Alabama, Florida, Georgia, Kentucky, Louisiana, Arkansas, Mississippi, North Carolina, South Carolina, and Tennessee

e) Midwest:
Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin

f) West:
Alaska, California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming

g) Southwest:
Arizona, New Mexico, Oklahoma and Texas.

Much of the information involves partial separation, and thus covers the cost of separating only a portion of the combined sewer system. Other figures provided refer to complete separation. This is the cost of separating the entire combined sewer system. But in neither case do these costs include the expense of plumbing changes on private property required to achieve total separation. These plumbing costs vary considerably due to local conditions, but are often quite high.

The costs of alternate solutions which do not require separation and the cost of separating sewers in conjunction with urban renewal projects.

were also tabulated. Urban renewal enables a municipality to upgrade large areas in its business, commercial and other districts. This almost always requires sewer changes and Federal aid regulations require sewer separation in such cases.

The cost data reported was separated into regional and national figures and is summarized in Table IX-B. This shows the costs per acre, and per capita served, both for complete and partial separation.

TABLE IX-B—SUMMARY—REPORTED COST OF SEPARATION BY REGION

Partial Separation

	Cost per Acre			Cost per Capita		
	Range	Average	Median	Range	Average	Median
New England	$ 285- 3,550	$ 1,530	$ 1,250	$ 55-2,360	$ 350	$205
Middle Atlantic	50- 3,270	1,310	1,305	21-1,360	295	122
South Atlantic	900- 1,220	1,105	1,200	110- 575	375	430
Southern	450- 2,390	1,140	950	65- 340	160	70
Midwest	105- 5,000	1,085	800	15- 360	115	100
West	335-10,800	1,990	675	60-1,620	292	75

Complete Separation

	Cost per Acre			Cost per Capita		
	Range	Average	Median	Range	Average	Median
New England	$5,800-55,800	$19,000	$10,000	$480-1,160	$ 700	$630
Middle Atlantic	4,550-42,900	13,000	11,000	430-2,720	1,125	640
South Atlantic	6,700-27,500	13,100	7,300	415-1,250	790	750
Southern	1,420-27,500	8,930	5,450	445-1,220	670	510
Midwest	100-29,000	5,720	3,590	25-2,660	630	415
West	290-16,700	4,940	1,700	60-5,000	600	280

Partial Separation

The data gathered by the survey on partial separation varied widely. Approximately 70 communities submitted data. As shown in Table IX-B, the costs ranged from $50 to $10,800 per acre. The average cost was $1,380 per acre, and the median, $1,045. Per capita costs ranged from $15 to $2,360 and averaged $330. The median was $125. Since the costs were not accompanied by any figures showing the extent of the separation, the figures reported are of limited value.

TABLE IX-C—REPORTED COSTS PER ACRE FOR PARTIAL SEWER SEPARATION PROJECTS, 1962-7[1] BY POPULATION GROUP AND DRAINAGE BASIN

Population Group in 1,000's	$ per Acre	Population Group in 1,000's	$ per Acre
0-500	—	25,001-50,000	1,050
501-1,000	—	50,001-100,000	3,110
1,001-5,000	870	100,001-500,000	690
5,001-10,000	825	Over 500,000	2,850
10,001-25,000	1,380		

Drainage Basins	$ per Acre	drainage Basin	$ per Acre	Drainage Basin	$ per Acre
1	625	7	1,340	13	1,740
2	10,000	8	550	14	3,640
3	1,850	9	810	15	—
4	—	10	—	16	—
5	1,740	11	—	U.S.	1,150
6	2,160	12	5,080	—	—

[1] This list averages computed for totals supplied by the respondents. In many instances, they reported only area or total cost, not both.

The survey also obtained cost data on sewer separation work actually completed between 1962 to 1967. As shown in Table IX-C, these are much lower than the figures previously mentioned. The reason is that the costs reported are believed to be for projects in areas of low population densities where construction would not be difficult. This information supplements, rather than corroborates, other cost data.

Complete Separation

The cost of complete separation ranged from $100 to $55,800 per acre and $25 to $5,000 per capita.

Reported costs were higher in the New England and Middle Atlantic states than in the Midwest and West. The Southwest region was not listed inasmuch as no cost information was reported by jurisdictions in that area.

The lack of information for various jurisdictions in all regions precluded other than a national extrapolation of cost. However, at the specific request of the FWPCA, basic assumptions were made so that cost data could be projected and presented on a state-by-state basis.

In order to accomplish this, the reported costs were further analyzed by population groups within each region. The average cost of complete separation was determined for each population group and the density of population determined for the communities that reported separation cost information. The average costs for each population group varied widely. The projected density for each population group had previously been determined. For most population groups there was a difference between the population density of the jurisdictions reporting cost information and the projected population density.

It was assumed that, generally, the cost per acre would remain the same for each population group but that the cost per capita would vary with the density in an inverse manner. That is, if the projected density were lower than the density of the communities which had reported, the unit cost per capita would increase. Therefore, the average cost for each population group was adjusted on the basis of the ratio of the population densities. The resulting average cost per capita again varied widely within each population group. Therefore, an average cost for all population groups was determined by multiplying the projected population by the adjusted unit cost for each population group, adding these together and dividing the total thus obtained by the total projected population. This resulted in a figure of $835 per capita as the cost of public sewer construction to effect complete separation. On a national basis this amounts to $30,391,645,000.

The state-by-state costs are given in Table IX-D. The figures for each state are based on cost data supplied by communities from many states, thus the individual state costs must be regarded as rough approximations.

It is important to note that many large cities did not submit cost figures for separation, probably because they felt that the probability of such work is remote. These cities are heavily built up and intensely populated. Their omission from the cost calculation lowers the resulting cost. For instance, in many large cities conventional separation is all but impossible because of the tremendous development which exists under street surfaces with existing pipes, subways and other utilities.

TABLE IX-D—ESTIMATED COST OF COMBINED SEWER SEPARATION

STATE	Complete Separation of Combined Sewers (Public)	Plumbing Changes to Affected Buildings	Total Separation
Alabama	$ —	$ —	$ —
Alaska	8,350,000	3,950,000	12,300,000
Arizona	—	—	—
Arkansas	25,700,000	23,300,000	49,000,000
California	712,000,000	547,000,000	1,259,000,000
Colorado	35,400,000	17,000,000	52,400,000
Connecticut	373,000,000	146,000,000	519,000,000
Delaware	81,300,000	52,600,000	133,900,000
District of Columbia	334,000,000	119,000,000	453,000,000
Florida	3,720,000	1,490,000	5,210,000
Georgia	317,000,000	191,900,000	508,900,000
Hawaii	—	—	—
Idaho	15,750,000	300,000	16,050,000
Illinois	4,270,000,000	2,420,000,000	6,690,000,000
Indiana	1,710,000,000	872,400,000	2,582,400,000
Iowa	326,000,000	188,800,000	514,800,000
Kansas	109,500,000	46,000,000	155,500,000
Kentucky	490,000,000	264,390,000	754,390,000
Louisiana	—	—	—
Maine	243,000,000	116,500,000	359,500,000
Maryland	19,500,000	4,520,000	24,020,000
Massachusetts	1,425,000,000	926,330,000	2,351,330,000
Michigan	2,430,000,000	1,548,500,000	3,978,500,000
Minnesota	423,000,000	189,600,000	612,600,000
Mississippi	335,000	52,000	1,387,000
Missouri	972,000,000	605,000,000	1,577,000,000
Montana	20,950,000	7,450,000	28,400,000
Nebraska	263,000,000	96,700,000	359,700,000
Nevada	33,000,000	6,770,000	39,770,000
New Hampshire	196,000,000	106,450,000	302,450,000
New Jersey	990,000,000	753,500,000	1,743,500,000
New Mexico	—	—	—
New York	7,100,000,000	4,366,000,000	11,466,000,000
North Carolina	6,320,000	1,360,000	7,680,000
North Dakota	64,300,000	17,400,000	81,700,000
Ohio	2,410,000,000	1,532,800,000	3,942,800,000
Oklahoma	—	—	—
Oregon	372,000,000	219,000,000	591,000,000
Pennsylvania	2,300,000,000	1,396,500,000	3,696,500,000
Rhode Island	231,000,000	204,700,000	435,700,000
South Carolina	—	—	—
South Dakota	16,600,000	8,240,000	24,840,000
Tennessee	173,000,000	111,700,000	284,700,000
Texas	69,000,000	42,800,000	111,800,000
Utah	—	—	—
Vermont	116,500,000	28,220,000	144,720,000
Virginia	228,000,000	128,400,000	356,400,000
Washington	610,000,000	478,000,000	1,088,000,000
West Virginia	280,000,000	179,080,000	459,080,000
Wisconsin	585,000,000	408,000,000	993,000,000
Wyoming	1,420,000	557,000	1,977,000
	$30,391,645,000	$18,378,259,000	$48,769,904,000

Note: (—) Indicates no evidence available that combined sewers are used in state.

At this point, it would be helpful to compare population figures with those obtained from previous studies by other investigators. This survey indicates that 51,079,246 people reside in the surveyed communities served partially or wholly by combined sewers. By extrapolation, this means that 54,771,500 people in the entire United States live in such muncipalities. A 1964 Preliminary Appraisal by the Public Health Service reported 59,000,000 people in communities served by combined sewers. The interview technique employed in collecting the information for this study suggests that the lower figure of 54,771,500 is more reliable. However, this does not mean that total population of all these communities, which are added together to give this figure, are served by combined sewers. The figures used in the calculations exclude those portions of such communities making use of separate sewers and the population served by separate systems.

Plumbing Changes to Achieve Total Separation

In order to eliminate the large volumes of storm water flow which enter a combined sewer from other than catch basin connections, it is necessary to make extensive plumbing changes in and on private properties connected to the system. When these plumbing changes have been made total separation has been achieved.

A search was made to obtain figures on the cost of plumbing changes within and on private property which would be required to effectively separate storm water from sanitary sewage. Plumbing changes are required in order that all down spouts and other "clean water" connections are separated from the sanitary system. This work is expensive and involves either tunneling under a building, if there is no basement, or cutting the basement floor to get at the sewer connections. Public officials report that when sewer separation projects have been initiated, it has been difficult to get the property owners to disconnect the sources of storm water inflow or make the necessary connections to the separate system. In some instances, public agencies have undertaken to finance such costs.

The only reliable cost information which was found was from the city of Washington, D. C. This city has, for several years, had an intensive program of working on a voluntary basis with property owners in selected areas to disconnect downspouts, roof drains, foundation drains, areaway drains, air conditioning and cooling system drains, yard drains, catch basin drains and similar connections from the sanitary system. Unit costs have been developed for various types of single-family residences varying from a low of $890.00 for row houses to $3,480.00 for homes on ½ acre lots. Limited experience has been gained in separating sewers from commercial and apartment buildings. Costs, to date, have ranged from $100.00 to $50,000.00 per unit. As it was necessary to make a projection of what plumbing costs would be incurred in a sewer separation program, the figure of $1,700.00 per single family dwelling unit and $3,400.00 for a multi-family apartment building and commercial structure were selected. These costs were adjusted for each area on the basis of the Engineering News-Record cost index for sewer construction as of September, 1967. Additional information on plumbing costs was made available from an unpublished study prepared for the American Society of Civil Engineers on the estimated costs of sewer separation in a neighborhood of San Francisco, California. This study estimated that the plumbing costs involved would be slightly lower than those reported by Washington, D. C. This difference may be due to the San Francisco plumbing code adopted in 1906 requiring that clean water enter the sewer system at only one point, thus reducing separation costs.

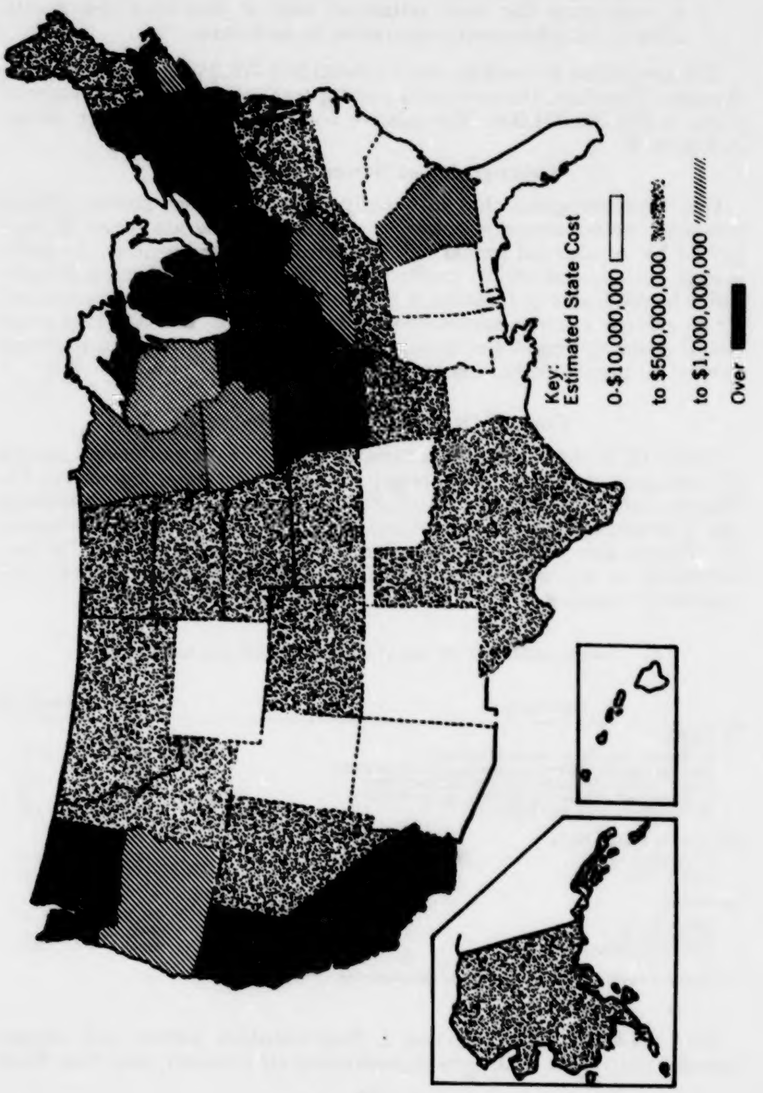
It must be understood that only limited data on the number and types of structures were available for many of the states, and it was necessary to use the cost figures indicated above to make projections of the estimated cost of changing plumbing connections for separation programs in individual states.

From the U. S. Census of Housing 1960, single-family structures and the number of multi-family structures was determined for each community included in the survey. A literature search was made to determine the ratio of commercial structures to multi-family structures. Only limited information of this type was available. However, contact with the city of Denver, Colorado and a study made of 9 Connecticut cities indicated that a ratio of 3 commercial structures for each 4 multi-family structures would be a reasonable ratio to use. For purposes of calculation, it was assumed that cities under 5,000 population generally would not require plumbing changes as their density is so low that roof drains, foundation drains and the like, usually are not connected to the combined sewer.

The following procedure was used to determine the estimated cost of making plumbing changes to achieve total separation:

1) The total population, the population served by combined sewers, the number of single-family structures, and the number of multi-family structures were listed in three categories for each state as follows: (a) population of surveyed communities of over 25,000; (b) population of surveyed communities in the 5,001 to 25,000 group; and (c) population of non-surveyed communities in the 5,001 to 25,000 group
2) The average number of persons per family unit for each state, as determined from the 1960 census, was multiplied by the number of single-family units in each of the three population groups to determine the number of persons living in such units—it was assumed that the remainder of the total population was housed in multiple-family structures
3) The number of persons assumed to live in multi-family structures was divided by the number of such units in each population group to determine the average population per multi-family structure. This number was then divided into $3,400—the estimated plumbing cost for connecting multi-family structures to separate sewer systems to determine the cost per capita
4) Commercial and multi-family structures are generally located in or near the core area of the community—if combined sewers exist they generally serve the core area—therefore, it was assumed that the population served by combined sewers was made up primarily of persons living in multi-family structures, plumbing costs for persons residing in single-family structures were included only if the combined sewer population was greater than the population estimated to be living in multi-family structures
5) The number of residents of multi-family structures served by combined sewers was multiplied by the cost factor computed in step 3 to determine the cost of plumbing changes from multi-family structures in each of the three population groups
6) The cost computed in step 5 was multiplied by 75 percent to approximate the cost of plumbing changes for commercial structures
7) The number of single-family residents assumed to be served by combined sewers was multiplied by a single-family cost factor of $1,700, divided by the average number of persons per family unit,

FIG. X. RELATIVE COST OF COMPLETE SEWER SEPARATION BY STATES.


Key:
Estimated State Cost
0-$10,000,000
to $500,000,000
to $1,000,000,000
Over

taken from the 1960 census figures, to determine the cost of single-family structure plumbing changes

8) For the projected additional population, it was assumed that the characteristics of housing were the same as for the communities surveyed in the 5,001-25,000 population group
9) Each population group was treated separately and added together to determine the total estimated cost of plumbing changes to achieve complete sewer separation in each state.

The projection of costs by state totaled $18,378,259,000 for plumbing changes. Therefore, the estimated cost for total separation, on a national basis, is $48,769,904,000. The relative costs are summarized by states in Figure X.

Intangibles of Sewer Separation

One must recognize that in heavily populated areas public opinion probably would strongly oppose a separation program, even if supported by substantial grants from Federal or State agencies. As mentioned earlier, industrial and commercial areas would undoubtedly suffer heavy losses in business if their streets were closed or obstructed by an extensive sewer construction program. People in residential areas would probably resent the inconvenience unless the affected areas were subject to persistent basement flooding.

Cost of Other Corrective Measures

Table IX-E shows that wide variations exist in the extent and nature of treatment provided or proposed for combined sewer overflows. Ft. Wayne, Ind., Port Huron, Mich., and Lancaster, Pa. are considering use of screening alone or in combination with other treatment methods. Ft. Wayne also plans to use sedimentation; Fort Smith, Ark. is participating in an experiment utilizing centrifuging and air flotation, following screening.

TABLE IX-E—COST OF TREATMENT OF OVERFLOW WASTES

Municipality	Cost	
	Per Acre	Per Capita
(a) General		
Ft. Wayne, Ind. (Screening and Settling)	$ 357	$ 35
East Chicago, Ind. (Deep retention lagoon and aeration)	450	—
New York City (Off-system storage and treatment)	3,500	56
Ft. Smith, Ark. (Screening, centrifuging, air flotation)	36	8
San Francisco, Calif. (Air flotation)	3,500	133
(b) Chlorine Contact Tanks		
Haverhill, Mass.*	900	—
Lowell, Mass.	51	4
(c) Screens		
Lancaster, Pa.	116	—
Ft. Wayne, Ind.*	2,400	—
Port Huron, Mich.*	2,180	280

* Project costs probably include sewers and appurtenances.

East Chicago, Ind. will test a deep-retention lagoon and oxygen transfer units. San Francisco is considering air flotation; and New York

City has been incorporating sedimentation and disinfection with off-system storage.

Cambridge, Haverhill and Lowell, Mass. will disinfect combined sewage overflows. Cambridge will use a holding tank; Haverhill and Lowell have considered chlorine-contact basins. Costs for such projects range from $36 to $3,580 per acre. The average per acre cost is $1,675. Per capita costs range from $8 to $280 and the average per capita cost is $103.

The variations in cost of chlorine-contact basins, shown in Table IX-E suggest the inclusion of other treatment features in the specific processes covered by reported estimates. Similarly, screening installation costs range widely, probably for the same reason.

Table IX-F presents cost data for projects involving additional sewer capacity. The costs reported by eight communities range from $127 to $4,800 per acre and from $18 to $195 per capita. The additional sewer capacity will overcome hydraulic overload problems. In particular instances the supplementary sewers add to in-system storage capacity.

TABLE IX-F—COST OF ADDITIONAL SEWER CAPACITY

Community	Cost	
	Per Acre	Per Capita
Oak Park, Illinois	$ 2,600	$ 57
East Detroit, Michigan	2,100	195
Hamtramck, Michigan	475	18
Paterson, New Jersey	4,800	155
Syracuse, New York	127	—
Springfield, Ohio	1,380	164
*St. Helena, Oregon	10,800	1,620
Port Angeles, Washington	250	46

*Storm sewer only

Four communities provided cost data for pumping station improvement programs (Table IX-G). Increases in station capacity and elimination of bypasses constituted such overflow remedial actions. Costs varied from $60 to $1,000 per acre and from $1 to $30 per capita.

Cost variations can occur depending upon station location and loading. Both are dependent upon the loading of the sewers tributary to the station wet well and are related to the contributed sewer loading.

TABLE IX-G—COST OF PUMPING STATION IMPROVEMENTS

Community	Cost	
	Per Acre	Per Capita
Wausau, Wisconsin	$ 60	$ 30
Ottawa, Ohio	73	9
Newport, Rhode Island	130	14
Pasco, Washington	1,000	1

As mentioned earlier, the use of storage to reduce overflows during hydraulic peak flows has definite advantages. Table IX-H lists several examples ranging from in-system storage, with and without flow regulation and monitoring, to storage in lagoons. Costs range from $20 to $6,500 per acre. Per capita costs range from $6 to $1,300. Additional treatment facilities used to augment a lagoon system, if used, would increase such costs.

TABLE IX-H—COST OF STORAGE OF OVERFLOW WASTES

Community	Type	Cost Per Acre	 Per Capita
Bedford, Ohio	Not indicated	$1,000	$ 200
East Cleveland, Ohio	Off-system	6,500	1,300
Cincinnati, Ohio	Retention tanks	22	—
Cairo, Illinois	In-system	2,570	—
Hammond, Indiana	In-system	900	—
Nashua, New Hampshire	Storm tanks	615	135
Madison Heights, Mich.	In-system	20	—
Saginaw, Michigan	Lagoon	415-5,140	62-670
Minneapolis-St. Paul, Minn.	In-system & regulation	98	6
Municipality of Metropolitan Seattle, Wash.	In-system & regulation	76	7

Elimination of improper connections is significant because of the wide variety and nature of interconnecting sewers in a separate system. These can result not only in hydraulic but also organic and inorganic overloads. Table IX-I lists several communities that have provided cost estimates on a per capita and per acre basis. One of them estimates the cost of catch basin separation at $300 per acre and a per capita cost of $150.

TABLE IX-I—COST OF ELIMINATING IMPROPER CONNECTIONS

Community	Cost Per Acre	 Per Capita
Marion, Ohio	$ 250	$ —
Coos Bay, Oregon	4,170	—
Corvallis, Oregon	150	—
Cottage Grove, Oregon	125	85
Hood River, Oregon	1,800	125
Newport, Oregon	190	40
*Wausau, Wisconsin	300	150
Average	1,160	80

*Separation of Catch Basins.

Table IX-J presents cost data which relate to different types of projects designed to limit and control storm water overflow. Columbus, Ohio will improve its existing holding basins with automatic sluice gates and solids collecting equipment. Medina, N. Y. will regulate diversion of storm water flows. The Wyandotte, Mich. project will use remote controlled regulation of flow. Those submitting the per capita and per acre cost estimates did not specify whether they involved the total or only a portion of the population and area served.

TABLE IX-J—COST OF SPECIAL PROJECTS

Community	Per Acre	Per Capita
Wyandotte, Michigan (1)	$ 59	$ 3
Minneapolis-St. Paul Sanitary District (2)	7	—
Medina, New York (3)	667	140
Columbus, Ohio (4)	12	—
Municipality of Metropolitan Seattle, King County, Washington (5)	76	7

(1) Remote control regulators.
(2) Flow regulation and monitoring.
(3) Regulation of storm water diversion.
(4) Solids collection equipment and automatic sluice gates for flow regulation.
(5) In-system storage and automatic flow regulation.

Table IX-K lists costs reported by four cities considering combinations of two or more solutions.

TABLE IX-K—COST OF COMBINED SOLUTIONS
(See text for nature of projects)

Community	Cost	
	Per Acre	Per Capita
Shelbyville, Illinois	$ 4,180	$ 627
Nashua, New Hampshire	2,560	570
Newburgh, New York	647	122
New York, New York	3,500	56
Average	2,720	345

Nashua, N. H. is considering some sewer separation, holding tanks and disinfection. New York City has developed a plan of off-system storage and treatment; Newburgh, N. Y. proposes separation and disinfection, whereas Shelbyville, Ill. has plans which include relief sanitary and storm sewers, a new pumping station and force main, and holding tanks with sedimentation and chlorination. Note that project costs range widely.

Supplementary information provided cost data for urban renewal projects in four communities. Table IX-L lists this information. Costs range from $2,600 to $50,000 per acre. The latter figure includes construction of a trunk sewer, the cost of which was not given. Omission of this $50,000 per acre item provides a more realistic cost range of $2,600 to $6,250 per acre and $445 to $690 per capita. This is more rational, considering the fact that separation should be more easily and economically accomplished after existing buildings are razed and the area cleared as part of an urban renewal project.

TABLE IX-L—COST OF SEWER SEPARATION IN
URBAN RENEWAL PROJECTS

Community	Sewer Separation Costs	
	Per Acre	Per Capita
Kingston, N. Y.	$ 2,600	$ 465
Huron, Ohio	6,250	690
Nashville, Tenn.	5,450	445
*Alexandria, Va. Sanitary Authority	50,000	—

*Includes trunk sewer

Comparison of Costs of Sewer Separation and Alternate Methods

Tables IX-E through IX-K indicate a general range of per capita costs of less than one-half the cost of sewer separation. In addition, and of major importance, the cost of plumbing changes would not be required for these solutions. Sufficient data are not available to make a national projection of costs for the alternative methods. As would be expected, no single method would be appropriate for all communities. The optimum solution will be to use a combination of methods. Each jurisdiction must evaluate the feasibility of each method or combination of methods in the light of local conditions. This, in itself, should result in reduced unit costs.

Comparison of Costs With Other Studies

The 1964 "Preliminary Appraisal, Pollutional Effects of Storm Water and Overflows from Combined Sewer Systems," prepared by the Public Health Service, presents estimates that are useful to compare with this study. Included were cost data for complete and partial separation, unit costs for changes in plumbing and house connections, and costs of alternate solutions such as holding tanks, chlorine-contact tanks, and lagoons. Table IX-M compares the finding.

TABLE IX-M—COMPARISON OF COSTS, 1964 PHS STUDY AND 1967 APWA STUDY

	PHS	APWA	
		Total Pop.	Affected Pop.
Population of Jurisdictions Served by Combined Sewers	59,000,000	54,295,000	—
Population Served by Combined Sewers	—	—	36,326,000
Complete Separation, Cost per Acre	$11,800	$ 3,750	$ 10,200
Complete Separation, Cost per Capita	$ 465	$ 554	$ 835
Population Density, Persons per Acre	25	6.7	12.2
Estimated Cost of Separation (Excluding Plumbing Changes)	$20-30 Billion	—	$30 Billion
Estimated Cost of Total Separation, Including Plumbing Changes on Private Property	—	—	$48 Billion

Plans for Financing Projects to Reduce Combined Sewer Overflows

One final item pertinent to the subject in this section is: Did the survey disclose whether the communities interviewed seriously intend to correct their overflow problems?

Officials of 233 out of the 641 jurisdictions reporting stated that plans are being prepared, either to separate the sewers or to build alternate works. Of these, 177 had made cost estimates and were considering financing methods, and 148 were far enough along so that they had determined that financing was a critical factor.

A total of 152 out of 245 responding to questions about the firmness of their plans, said that their proposed construction plan was in a current 5 to 7 year capital improvement program. For the remainder, their starting dates ranged from 1 to 16 years with an average of 9 years.

The persons interviewed in 245 communities indicated that the planned improvements would be financed by means of one or more of these methods:

Pay-as-you-go	60
Accumulated reserve funds	17
Special user charges	66
Bonds	200
Other (probably grants)	48

A number of the respondents provided multiple answers to the question on methods of financing their proposed projects.

SECTION X

THE CONTRACT AND ITS IMPLEMENTATION

Intent of contract
Sample selection of communities
Staff, interviews, liaison personnel and consultants
Survey procedure

SECTION X

THE CONTRACT AND ITS IMPLEMENTATION

On May 17, 1967, the U. S. Department of Interior, through the Federal Water Pollution Control Administration, entered into a contract with the American Public Works Association to conduct a study of combined sewer systems throughout the nation. The scope of the work to be performed was described in the following provisions of the contract:

"A. **Intent**

1. To obtain, by on-site personal interviews of representatives of approximately 900 communities, sufficient information pertaining to the combined sewer systems of said communities to facilitate definition of the problem on a nationwide basis.
2. To review, correlate and otherwise methodically obtain optimum results from the data gathered during the interviews to the extent of supplying wide-scope source information which will assist the expeditious pursuit of the program authorized by Section 6a (1) of the Federal Water Pollution Control Act, (PL 84-660), as amended.
3. To prepare a report which will contain the results of A.1 above and such other information as required to assure that the requirements of Section 16a of the Federal Water Pollution Control Act, (PL 84-660), as amended, can be met insofar as they pertain to the program authorized by Section 6a (1)."

The Contract sets forth the procedures by which the "Intent" of the project is to be accomplished, as follows:

"B. **Sample Selection of Communities**

The Contractor shall select from the list of communities furnished under paragraph E. 3, below, those communities to be included in the inventory. This list tabulates the communities with combined or partially combined sewer systems and their population, by state and county. All communities over 25,000 (approximately 300) will be queried. A maximum of thirty percent (30%) of the remaining communities shall be sampled. The maximum total sample shall be 900 communities.

Selection of communities under 25,000 population to be included in the sample shall be made in accordance with the following procedure:

1. A maximum of thirty percent (30%) of the listed communities in each state shall be sampled except that for those states with 10 or fewer listed communities all above 2,000 population shall be sampled.
2. Selection is to be based on a broad geographical distribution of communities within each county, and the counties within each state.

3. Actual community selection shall conform to good statistical procedures and practices."

Staff, Interviewers, Liaison Personnel and Consultants

A staff of highly trained and experienced sanitary engineers and municipal officials was retained to direct the work involved in carrying out the project. Principals were:

Director—Clyde E. Palmer, Consulting Engineer and former City Engineer, Detroit, Mich.

Associate Director—Dr. Morris M. Cohn, Consulting Engineer and former Editorial Director of *Water Works Engineering* and *Wastes Engineering;* and former City Manager of Schenectady, N. Y.

Project Administrative Officer—Calvin M. Lakin, former City Manager, Port Huron, Mich., and recently a consulting staff member of Public Administration Services, Chicago.

Director of Staff Services—Richard H. Sullivan, Assistant Director for Technical Services, APWA, former City Administrator, Atwater, California, and former Assistant Director of Public Works, Phoenix, Arizona.

Members of the Board of Trustees, APWA Research Foundation, provided advisory services. Samuel S. Baxter, Foundation Chairman; Edward J. Cleary, Vice Chairman; and Robert D. Bugher, Executive Director of APWA and Secretary-Treasurer of the Foundation, served as the Steering Committee, and exercised general control and direction of the project.

In order to interview the selected municipalities in the time allotted, the APWA recruited a well qualified staff of 41 persons. The men selected came from the following professional groups: city engineers, utility managers, city managers, sanitary district managers, consulting engineers, superintendents of streets and sewers, and sanitary engineering professors and instructors.

APWA also made use of representatives of its state, regional and local chapters to serve as liaison personnel between field operations and headquarters staff. These men were experienced in sewer system practices and were personally acquainted with local government officials in their areas.

In order to obtain the benefit of persons experienced in this field, the APWA Research Foundation established an advisory group consisting of seven outstanding consulting sanitary engineering firms. This group met prior to the beginning of the interviews to review the project and evaluate with the APWA the plans for conducting the interviews and interpreting the survey data. After the field data had been tabulated the advisory group met again to help the staff interpret the findings.

Survey Procedures

The Contractor provided the mayor or chief administrative officer of each of the selected jurisdictions with a copy of the interview form, FWPCA Form 103, together with a request that he return promptly a response card, indicating that his community, district or other entity did or did not have combined sewer facilities. APWA also asked for the names of officials in charge of the sewer system and water pollution control plant who should be contacted to obtain the pertinent information. Telegrams were sent to those officials who did not respond promptly, supplemented by calls from the liaison officer in the area, if necessary. In a few cases, the interviewers made their own contacts and arranged their own schedules, when other means of obtaining responses proved ineffective.

All interviewers and liaison members received indoctrination in the purposes of the surveys, instructions on data to be obtained, and the manner that they could best obtain it. Seven one-day instructional conferences were conducted for this purpose. The APWA staff had the benefit of a two-day session on interviewing techniques conducted by the National Opinion Research Council in Chicago. During the interview period, five "feedback" conferences were held to learn of the survey's progress to that date, to make changes in interview assignments where necessary, and to give further instructions as needed.

To insure accuracy, APWA made a sampling verification of data from 17 cities, all with more than 25,000 population. This represented five percent of the cities in this population range, for which the contract required 100 percent coverage.

Eight replies were received. All established the validity of information supplied at the time of the original interview. Five reported all data confirmed and correct. Three attested to the accuracy of the original responses but reported certain operational changes which had occurred during the six-week interval.

Any survey has limitations. The use of personal interviews resulted in better and more complete data than is generally attained. Every effort was made to minimize the problems of proper interpretation and variances between the different interviewers and regional interpretation. It is assumed that respondents gave the best information or estimate available. Nevertheless, differences of opinion and interpretation and degree of accuracy in reporting exist. Therefore, information contained in this report should be used with its limitations in mind.

In many cases, members of the survey team submitted comments with their reports on the interviews. A summary of these comments, as well as such material as lists of engineering reports received, jurisdictions contacted and found not to have combined sewers, the original interview reports, and the 1,600 pages of print out based on information submitted for automatic data processing have been presented to the FWPCA as separate documents.

SECTION XI

ACKNOWLEDGEMENTS

Panel of consultants
Interviewers and liaison personnel
Special consultants

SECTION XI

ACKNOWLEDGEMENTS

The American Public Works Association is deeply indebted to the interviewers and liaison personnel for the services they rendered to the APWA Research Foundation in carrying out this study for the Federal Water Pollution Control Administration. Without their cooperation and assistance the extensive interview program provided for in FWPCA Contract No. 14-12-65 could not have been completed within the time specified. The service provided by the Panel of Consultants was of considerable value in the conduct of this project, as were those of the Special Consultants.

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Project No. 123

PROBLEMS OF COMBINED SEWER FACILITIES AND OVERFLOWS—1967

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APWA FOREWORD

AS CONTAINED IN ORIGINAL PRINTING

The detailed report which follows gives results of a survey made by the APWA Research Foundation under contract with the Federal Water Pollution Control Administration, and the findings, conclusions and recommendations resulting therefrom. Through a close relation with the project from its inception to its completion, the writer expresses some viewpoints gained from the review of the data and meetings with the contractor's staff and consultants. The following comments are based on the overall review of the project rather than on the individual points and questions surveyed.

There is no doubt about a general interest in the problem of combined sewer overflow. On the other hand, except for a few cases, local interest has evidenced itself only in a willingness to carry out some pilot research on several facets of the problem, and this with substantial grants from the federal government.

It appears that the large sums of money needed to eliminate or abate combined sewer overflow have caused such projects to be given a low priority because of the feeling that there is greater need for other pollution abatement projects or other work requiring local funds.

The survey indicates that, in addition to planned overflows during storms at combined sewer outlets, there are considerable additional sanitary overflows and discharges from community sewer systems. Insufficient treatment plant capacity, infiltration, malfunctioning and lack of maintenance of overflow control devices are definite factors.

As it was not within the scope of the survey, no definite estimate of the amount of pollution from combined sewer overflows compared to the total liquid wastes discharged was made. However, estimates which have been made previously and which have been discussed during the period of the survey indicate that storm overflow from combined sewers may account for not more than 3 to 10 percent of the total pollutants discharged to the nation's waters from urban areas. There is a definite need for additional research on this point.

The cost estimates of combined sewer overflow abatement derived by the survey, matched against the cost and potential benefits of better maintenance of control devices, and higher levels of treatment in existing plants and reduction of plant bypassing, suggest that a real effort to correct the latter sources of waste water discharges could result in less pollution, in less time and at less cost.

Pollution abatement faces limitations in manpower and money. Plants that now provide only primary treatment need to be expanded to make use of secondary treatment; and in some cases secondary plants may have to be upgraded to meet higher water-quality standards.

There also is a real need for more and better supervision of water pollution control systems, and an urgent need for adequately trained operators. To this could be added the need for more funds for better maintenance practices and better salaries, each of which can be expected to improve the overall pollution control picture.

The APWA Research Foundation appreciates the opportunity to serve FWPCA in this project. While recognizing the need for the short time period provided for this survey by the contract it is apparent that additional survey and research work is needed on the extent to which combined sewer overflows pollute the Nation's water resources and how such pollution can best be reduced or eliminated.

This survey does, however, provide the most definitive information ever assembled on the nature and magnitude of the combined sewer problem in the United States.

Samuel S. Baxter, Chairman
Board of Trustees
APWA RESEARCH FOUNDATION

SECTION XII

APPENDICES

A. FWPCA Form 103.

B. Interpretive Data Work Forms.

C. Guide for Completion of Questionnaire.

D. Policies on Data Interpretation.

E. Selected Information by United States Totals.

F. Selected Information by State Totals.

G. Control and/or Treatment of Combined Sewer Overflows or Storm Water Discharges—An Engineering Memorandum.

H. Combined Sewers in Metropolitan Service—A Review.

I. Special Study: Economic Impact of Land Values at Combined Sewer Overflow Locations.

J. Supplemental Information Regarding Land Use, Highest Water Use and Nature of Receiving Waters in the Vicinity of Overflows from Combined Sewers and Other Sources.

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APPENDIX A

U S DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
WASHINGTON, D.C. 20242

BUDGET BUREAU NO. [illegible]
APPROVAL EXPIRES [illegible]

REPORT ON COMBINED SEWER FACILITIES

(See instructions below)

REPORT NUMBER

FOR OFFICIAL USE ONLY
☐☐
☐☐☐☐☐
☐☐☐
☐☐☐☐☐☐

1. LOCATION *(city, county, state)*

2. LIST FACILITIES SERVING COMMUNITY *(city, county, state)*

3. SYSTEM CHARACTERISTICS		SEPARATE SANITARY	SEPARATE STORM	COMBINED	UNSEWERED	TOTAL
A. AREA SERVED (ACRES)						
B. POPULATION SERVED						
C. COLLECTION SEWER (MILES)						
D. INTERCEPTOR (MILES)						
E. CAPACITY RATIO WWF/DWF*	COLLECTION SEWER					
	INTERCEPTOR					

4. OVERFLOW LOCATIONS		NO. OF LOCATIONS	NAME OF RECEIVING BODY (IES) OF WATER
A. COMBINED SEWERS			
B. TREATMENT PLANT BYPASS			
C. PUMPING STATION BYPASS	COMBINED		
	SEPARATE		
D. OTHER			

5. TREATMENT OR CONTROL OF COMBINED SEWER OR STORM WATER OVERFLOWS

TYPE	NO.	OPERATING REPORTS AVAILABLE	
		YES	NO
A. SCREENING			
B. DISINFECTION			
C. SEDIMENTATION			
D. IN-SYSTEM STORAGE			
E. OFF-SYSTEM STORAGE			
F. CHEMICAL			
G. AUTOMATED REGULATORS			
H. SEWER SEPARATION			
I. OTHER *(list)*			
J. TOTAL			

6. COLLECTION SYSTEM REGULATORS

TYPE	NO.	PERFORMANCE *(See instructions below)*
A. FLOAT OPERATED GATE		
B. TIPPING GATE REGULATOR		
C. HYDRAULIC CYLINDERS		
D. LEAPING WEIR		
E. SIDE OR SPILLWAY WEIR		
F. PERPENDICULAR WEIR (DAM)		
G. MANUAL OR AUTOMATIC VALVES		
H. SLOT OR DROP-INLET		
I. OTHER *(list)*		
J. TOTAL		

ITEM		YES	NO
7. HAVE COMBINED SEWER OVERFLOWS OR STORM WATER DISCHARGES BEEN MONITORED FOR INFORMATION ON:	A. QUANTITY DISCHARGED		
	B. QUALITY DISCHARGED		
	C. ARE REPORTS AVAILABLE?		
8 DOES THE CITY HAVE A ROUTINE MAINTENANCE PROGRAM FOR COMBINED SEWER OVERFLOW REGULATORS?			
9. ARE DRY WEATHER OVERFLOWS FROM COMBINED SEWERS A PROBLEM?			
9A. IF YES, ARE OVERFLOWS A RESULT OF:	TROUBLESOME REGULATORS		
	INSUFFICIENT SEWER CAPACITY		
10. IS INFILTRATION A PROBLEM DURING:	A. DRY WEATHER		
	B. WET WEATHER		
11. DOES INFILTRATION EXCEED THAT ALLOWED BY BUILDING CODE OR DESIGN CRITERIA?			
12. HAVE ENGINEERING STUDIES BEEN MADE TO DEFINE CORRECTIVE ACTION NEEDED FOR COMBINED SEWER AND STORM WATER OVERFLOW?			
12A. HAVE COSTS BEEN ESTIMATED?	IF YES, LIST AMOUNT		
12B. IF COSTS HAVE BEEN ESTIMATED FOR COMPLETE SEPARATION, INDICATE AMOUNT	AMOUNT		
12C. ARE REPORTS AVAILABLE?			

			YES	NO
13. DOES THE CITY HAVE CURRENT PLANS FOR CORRECTING PROBLEMS STEMMING FROM COMBINED SEWER AND STORM WATER OVERFLOWS BY:	A. SEWER SEPARATION	IF YES, LIST COST		
	B. ALTERNATIVE MEANS	IF YES, LIST COST AND ALTERNATE METHOD		
14. IS THE FINANCING OF THE CORRECTIVE CONSTRUCTION PROJECTS A DETERMINING FACTOR IN ACCOMPLISHING THE ABATEMENT PLANS?				

15. PREPARED BY *(Name and Title)*

DATE

INSTRUCTIONS

NOTE: Information on this form is being obtained for program purposes and cannot be considered confidential.

ITEM 1	Enter name of community for which survey is being made.
ITEM 2	Enter location of all facilities serving the community. *(Complete a separate form for each facility)*
ITEM 3	Enter area, population, length, and capacity ratio for each stated segment of the sewer system.
ITEM 4	Enter number of locations and name of receiving body of water, for each type of overflow listed.
ITEM 5	Enter number of treatment or control units for each type listed. Sum total and state whether or not operation reports are available.
ITEM 6	Enter the number of regulators for each type listed and rank their performance from 1 through 9 with number one being the most dependable and trouble-free, to no. 9 the most troublesome.
ITEM 7 thru 12	Self explanatory.
ITEM 13B	Alternative means can be interpreted to be one or more of the control or treatment methods listed in item 5. List alternate method by letter as listed under item 5, e.g. 5-A, 5-B, etc.
ITEM 14 & 15	Self explanatory.

FWPCA-103 (2-67)

*WWF– Wet Weather Flow; DWF–Dry Weather Flow, State Average or Range of Ratio for System

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AMERICAN PUBLIC WORKS ASSOCIATION

Interpretive Data

COMBINED SEWER OVERFLOWS

Revised 5-16-67

SHEET 1

Location__________ Report No.__________

Date__________

Interviewer__________

Respondent – Name / Title__________

NOTE: Question number is keyed to number of questions on questionnaire where further information is required. If respondent does not have information available, write in "D K"–Don't Know. If question is not applicable, write in N A.

1-1

Specify scope of jurisdiction responsibility Check all that are applicable	
a. Collection system	
b. Disposal (including interception system)	
c. Partial collection or disposal	

1-2

	yes	no
a. Does your jurisdiction accept wastes from combined sewer systems of other jurisdictions?		
b. Does your jurisdiction discharge wastes from combined sewer systems to other jurisdictions?		

3B-1

a. What is population equivalent of industrial wastes collected in your combined sewer system?	
b. What is population equivalent of industrial wastes collected in your separate sanitary system?	
c. If information is not available by system what is total population equivalent of industrial wastes reaching treatment plant facilities?	

3C-1

Of the total miles listed in Item 3C, show breakdown as follows:

Type of Construction in Past 10 Years	Miles Built		
	Separate Sanitary	Separate Storm	Combined
a. To serve new areas			
b. To reconstruct existing sewers			

3C-2

	yes	no
Does the jurisdiction have a tabulation showing size of sewers in each system? If yes, please obtain		

3E-1

For separate storm and combined sewer systems, what is the present design storm?

__________years

If time/intensity curves are available, please obtain.

3E-2

If the capacity ratio for interceptor sewer is more than 5:1 explain reason or thought behind the choosing of the high ratio.

3E-3

Characterize local flooding problems as a result of all systems

Type of Problem	Yes	No	% of City Area Affected
a. basement flooding			
b. manhole overflows			
c. underpass flooding			
d. other (please list)			

4-1 Catagorize characteristics of overflow points in the following table: Let respondent define vicinity

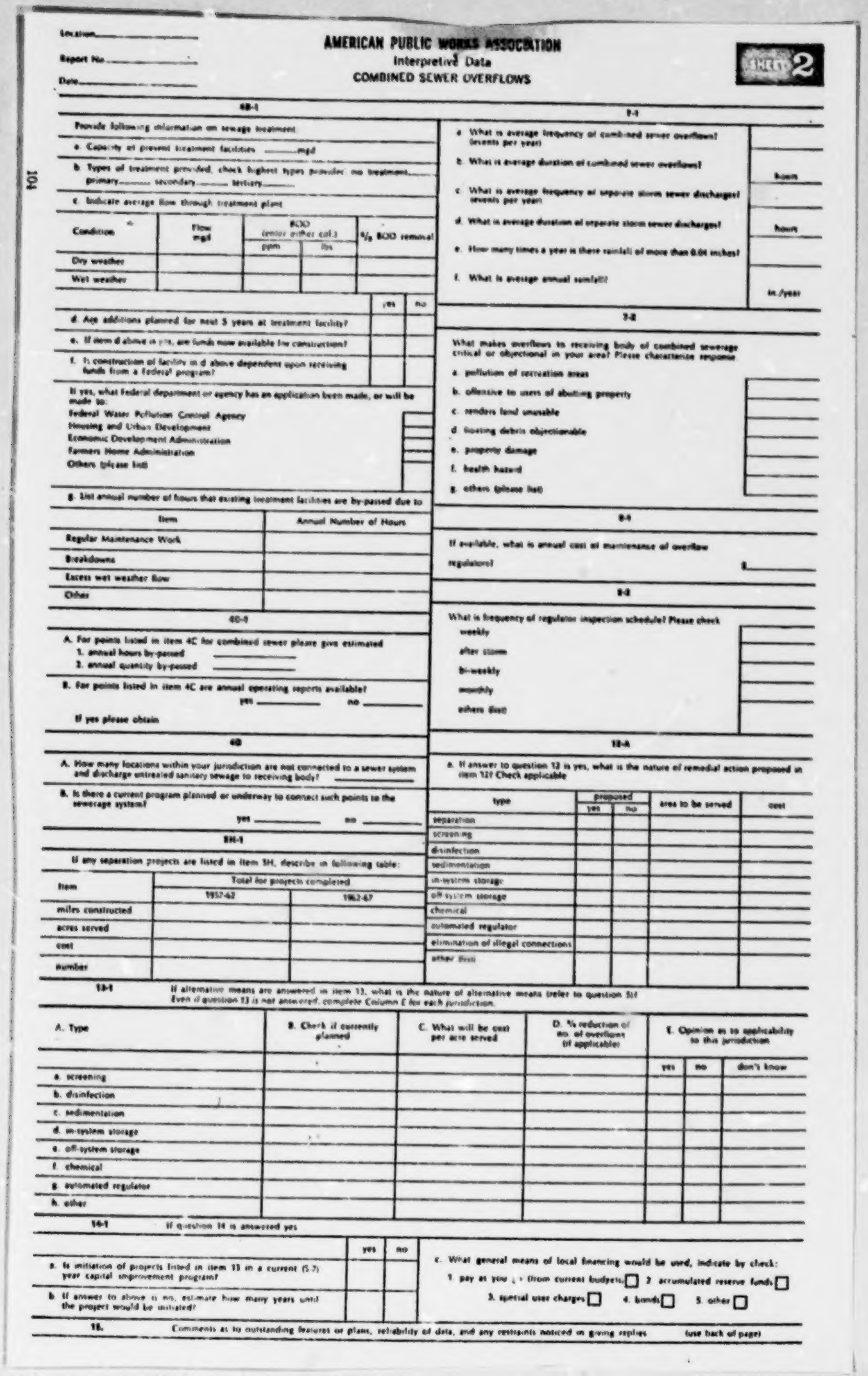
Present land use characteristics in the vicinity of overflow point	Number of Overflow Points from:			
	Combined sewers	Treatment Plant By-pass	Pumping Station By-Pass	Other
a. agriculture				
b. recreation				
c. residential				
d. industrial				
e. vacant				
f. commercial				
g. other				
Total				
No. of above listed points underdeveloped due to pollution				

4-2 Characterize present uses of receiving bodies in vicinity of outfall points in the following table. Let respondent define vicinity

Character of highest Water Use in Vicinity of Overflow point	Number of Overflow Points from			
	Combined sewers	Treatment Plant By-pass	Pumping Station By-Pass	Other
1. potable water source in gen. vicinity				
2. body contact recreation				
3. limited body contact recreation				
4. fishing				
5. shellfish				
6. industrial cooling				
7. industrial process water				
8. agriculture or irrigation				
9. open drains				
10. not otherwise specified				
Total Points				

4-3 Characterize the nature of receiving body in the following table:

	Number of Overflow Points from			
	Combined sewers	Treatment Plant By-pass	Pumping Station By-Pass	Other
1. lake				
2. tidewater				
3. normally dry watercourse				
4. a stream with a dilution factor of less than 5				
5. a stream with a dilution factor of from 5-10				
6. a stream with a dilution factor of from 10-100				
7. a stream with a dilution factor of over 100				
Total Points				



Location______________

Report No.______________

Date______________

AMERICAN PUBLIC WORKS ASSOCIATION
Interpretive Data
COMBINED SEWER OVERFLOWS

SHEET 2

4B-1

Provide following information on sewage treatment

a. Capacity of present treatment facilities ______mgd

b. Types of treatment provided, check highest types provided: no treatment_____ primary_____ secondary_____ tertiary_____

c. Indicate average flow through treatment plant

Condition	Flow mgd	BOD (enter either col.)		% BOD removal
		ppm	lbs	
Dry weather				
Wet weather				

	yes	no
d. Are additions planned for next 5 years at treatment facility?		
e. If item d above is yes, are funds now available for construction?		
f. Is construction of facility in d above dependent upon receiving funds from a Federal program?		

If yes, what Federal department or agency has an application been made, or will be made to:

Federal Water Pollution Control Agency	
Housing and Urban Development	
Economic Development Administration	
Farmers Home Administration	
Others (please list)	

g. List annual number of hours that existing treatment facilities are by-passed due to

Item	Annual Number of Hours
Regular Maintenance Work	
Breakdowns	
Excess wet weather flow	
Other	

4D-1

A. For points listed in item 4C for combined sewer please give estimated
1. annual hours by-passed __________
2. annual quantity by-passed __________

B. For points listed in item 4C are annual operating reports available?
yes ________ no ________

If yes please obtain

4D

A. How many locations within your jurisdiction are not connected to a sewer system and discharge untreated sanitary sewage to receiving body? __________

B. Is there a current program planned or underway to connect such points to the sewerage system?
yes ________ no ________

5H-1

If any separation projects are listed in item 5H, describe in following table:

Item	Total for projects completed	
	1957-62	1962-67
miles constructed		
acres served		
cost		
number		

7-1

a. What is average frequency of combined sewer overflows? (events per year)	
b. What is average duration of combined sewer overflows?	hours
c. What is average frequency of separate storm sewer discharges? (events per year)	
d. What is average duration of separate storm sewer discharges?	hours
e. How many times a year is there rainfall of more than 0.04 inches?	
f. What is average annual rainfall?	in./year

7-2

What makes overflows to receiving body of combined sewerage critical or objectional in your area? Please characterize response

a. pollution of recreation areas	
b. offensive to users of abutting property	
c. renders land unusable	
d. floating debris objectionable	
e. property damage	
f. health hazard	
g. others (please list)	

8-1

If available, what is annual cost of maintenance of overflow regulators? $________

8-2

What is frequency of regulator inspection schedule? Please check

weekly	
after storm	
bi-weekly	
monthly	
others (list)	

12-A

a. If answer to question 12 is yes, what is the nature of remedial action proposed in item 12? Check applicable

type	proposed		area to be served	cost
	yes	no		
separation				
screening				
disinfection				
sedimentation				
in-system storage				
off system storage				
chemical				
automated regulator				
elimination of illegal connections				
other (list)				

13-1

If alternative means are answered in item 13, what is the nature of alternative means (refer to question 5)?
Even if question 13 is not answered, complete Column E for each jurisdiction.

A. Type	B. Check if currently planned	C. What will be cost per acre served	D. % reduction of no. of overflows (if applicable)	E. Opinion as to applicability to this jurisdiction		
				yes	no	don't know
a. screening						
b. disinfection						
c. sedimentation						
d. in-system storage						
e. off-system storage						
f. chemical						
g. automated regulator						
h. other						

14-1

If question 14 is answered yes

	yes	no
a. Is initiation of projects listed in item 13 in a current (5-7) year capital improvement program?		
b. If answer to above is no, estimate how many years until the project would be initiated?		

c. What general means of local financing would be used, indicate by check:
1. pay as you go (from current budgets) ☐ 2. accumulated reserve funds ☐
3. special user charges ☐ 4. bonds ☐ 5. other ☐

15.

Comments as to outstanding features or plans, reliability of data, and any restraints noticed in giving replies (use back of page)

APPENDIX C

American Public Works Association
Research Foundation

Combined Sewer Overflows

Guide For Completion of Questionnaire
FWPCA-103

Item One—List the name of the city, sanitary district or township that is in charge of the facility.

Item Two—Omit—to be used by office in correlating data.

Item Three—Population, area, and mileage refer only to the portion of a system owned and administered by the jurisdiction listed on Item 1.

Use population count for 1967 or latest data since 1960 census.

Give length (mileage) of separate sanitary and separate storm sewers, physically constructed as such, even if they eventually become physically combined.

Where definite information is not available, give estimates as accurate as possible.

Interceptor sewers are defined as the principal sewers which collect flows from the collecting system and conveys flows to point of treatment or disposal. Collector sewers include all other sewers excluding house connections. Allow the respondent discretion in answering this question based on his knowledge of his own system and the manner in which his records have been compiled.

For Item 3C and 3D, do not include any mileage of collection and interceptor sewers administered by others.

For the purpose of this question, *unsewered* is defined as the absence of separate sanitary or combined sewers. For total column 3A and 3B disregard separate storm column answers.

Item 3E does not normally apply to separate sanitary or separate storm. For combined sewers use the present actual condition or if not known use the design criteria. Identify design criteria by asterisk.

Item Four—Number refers to the number of locations where overflow occurs.

Item Four D—Denotes any location not previously listed where raw sanitary sewage overflows can be discharged to the receiving body.

Item Five—The question specifies treatment or control—any facility that does not treat or control is not involved, such as non-automatic regulators.

Item Five A—Bar or other coarse screens are to be considered as screening.

Item Five D—In-system storage denotes where controls such as large pipe sizes, or in-system interception or diversion has been con-

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structed to retain the combined flow within the system with the goal of reducing the quantity of overflow.

Item Five E—Off-system storage denotes where a holding reservoir has been constructed to allow either sedimentation or eventual return to treatment.

Item Five F—If chemicals are used for disinfection, list as Item B. Item F would be for precipitation or some other goal.

Item Five G—Automated regulators denotes a system for the activation, control or correction of overflows by mechanical, hydraulic or electric controls. This does not refer to regulators listed in question 6.

Item Five H—Denotes projects undertaken in the past ten years to change a portion of a combined sewer system to separate sanitary. No size limitation.

Item Six—Collection system regulators are defined as the devices at the point at any connection between the collector and interceptor sewer.

The total must add up to the true total of number of regulators; there must be no duplications in listings 6A through 6I.

Interpret Item 6G as *other* manual or automatic valves other than those listed above. Item 6I may mean any other pumping device orifice, or valve. Exclude tide gates.

Instructions for rating performance are given on the bottom of the form. As a guideline one (1) should be used where the regulator is always functional and nine (9) where the regulator seldom functions. Probe for proper intermediate numbers to describe varying degrees of performance of regulators in system. The rating is for the group as a whole.

Item Seven—Quantity discharged should be answered yes only if there has been a means to accurately measure the flow. Quality discharged should be answered yes only if chemical and bacteriological tests have been made.

Item Eight—Inspections on a regular basis along with corrective action would be considered to be routine maintenance.

Item Nine A—This question should be interpreted as "Do dry-weather overflows occur?"

Item Ten—Infiltration problem during dry weather is defined as when the amount of infiltration affects adversely the design capacity of the system, including treatment facilities.

Wet weather is defined as the *season* as well as a rain storm.

Item Eleven—If respondent does not know rate of infiltration then answer must be DK, "Don't Know."

Item Twelve B—Refers to entire city.

Item Thirteen—May or may not refer to a plan for complete solution of pollution problems.

Item Fourteen—This item is to be answered only if Item 13 is answered yes.

APPENDIX D

POLICIES ON DATA INTERPRETATION

Item 2 of Form 103 has been used to indicate the first seven digits of the identification number of a sanitary district. If there is a sanitary district and city served by a sanitary district, this will allow sorting on the computer for the component parts of the district.

Wherever information has been listed which is unclear or misleading without more interpretative narrative data, the data have been deleted and "Don't Know" inserted.

Item 3A—Many cities did not provide any information. In cases where the interviewer obviously added the total of the separate storm system to the totals in Items 3A and 3B, the total figure was reduced to take out the separate storm figures. This may be approximately correct if the interviewer did not start with the total figures and work backwards. We have no way of checking this. Where a sanitary district serves an area, we have placed a minus sign in front of information, which if it were included in summary totals would in effect count twice acres, people or miles of sewer. The minus sign means that the figure will not be added to totals but will be used for correlations or computations.

In cases where substantial portions of the city are served by different systems, such as where only a part of the city's flow is treated, or where part of the city is served by a sanitary district, two separate reports have been prepared. There are a minimum number of these cases where the information was of such significance that it was deemed necessary.

Item 4A—Combined sewer overflow locations generally include direct discharges of raw sanitary combined sewage. In some cases this type of discharge was listed under 4D—along with discharges of separate sanitary sewage as well as other types of overflows.

Item 5—Many automated regulators were listed in Item 5G. Wherever this corresponded exactly with the number of float-operated gates and there was no narrative description, the item was removed. In many cases where there was a treatment plant, screening, disinfection, sedimentation and off-system storage was listed with one each. These were not generally corrected, but it is doubtful if they were referring to anything other than the treatment plant. There were very few cases where an automated regulator was listed and a narrative description was given which would bear out the designation.

Item 6—Total number of regulators is deceiving inasmuch as treatment plant bypasses and interceptor regulators were often listed, as well as "other," item 6 I, for many direct outfalls. Whenever possible, all of these were removed; however, if there was a doubt, the information was left in and therefore the totals are overstated. It is interesting to note that many regulators were rated very good or very bad depending apparently upon the philosophy of the respondent as to whether or not they accomplished regulation. Manhole overflows were often listed as side or spillway weirs or as 6I (other). Respondents seemed generally not inclined to classify this type of overflow device or its performance.

Item 7—Quantity and quality discharged were checked yes many times; however, it appeared that generally this referred to treatment plant discharges or bypasses and not to combined sewer overflows.

Item 10—Infiltration—In many cases this item was clarified by respondents on the Report to indicate limited areas of town or older sections of town.

Item 12—Wherever a Report was in progress or about to be made, the answer was changed to no. For Costs in 12A and 13B wherever treatment cost or relief by interceptor sewers were involved, the cost was removed. If the cost could not be readily ascertained, the entire cost was DK. Even though many of the treatment plant and relief and interceptor sewers would effectively reduce the number and amount of sewer overflows it was felt that this cost information would distort better data when it was supplied.

Item 1-1—Disposal was checked even though the city had no present treatment plants, as this indicates the responsibility for treatment.

Item 1-1C—Partial collection or disposal was allowed in rare instances where it seemed particularly important.

Item 3B1—In many instances it was apparent that the industrial loads were not properly listed, in other words, suspended solids instead of BOD loading as our people were instructed; however, the figures were not changed.

Items 4-1, 4-2 and 4-3—In many cases respondent could not or would not classify the features desired. In these instances, no information was given for the computer printout.

Item 4B1—Greatest difficulty in rounding figures was encountered in this question inasmuch as whole figures were used and many small facilities have a small capacity. It was unfortunate that in our survey we did not request a breakdown as to the total population served by the water pollution control plant.

Item 7-1—Items A and B were checked for 365 events—24 hours for those locations where the combined sewage did not normally receive treatment. This was done to indicate continuous discharge.

Item 12A—Lost much of the cost information inasmuch as more than one item was applicable, but information available to interviewers generally did not break out the cost of the various items. The same is true for Item 13-1 in those few cases where some type of construction is planned. Respondents did not have enough information to break out applicable costs or effect of the improvement. In those instances where separation was indicated as being planned, it was included in Item 13-1H and the same per-cost figures developed in 12A were used if not supplied by the interviewer.

Very few interviewers elicited responses as to applicability of various alternative methods to their jurisdiction.

Item 14-1—Was generally checked yes even though no project was planned. It was interesting to note that very few answers to Item 13 actually had been included in a capital improvement program nor was there a definite time when the project will be accomplished. It appears that this question was answered yes to give a favorable impression for the city, although there is no current plan or desire to accomplish construction. Many comments were received that construction would be started if Federal grants were available, without mentioning whether or not local money would be available.

As a general comment, many discrepancies in data occurred because of the meaning of "combined sewage" areas. In some cities it was specifically pointed out that only roof drains and foundation drains were connected to the sewer system and that these sewers were then classified as combined.

APPENDIX E

SELECTED INFORMATION
BY UNITED STATES TOTALS

INDEX TO UNITED STATES SUMMARY TABLES

NOTE: The following tables were prepared by automatic data processing. Whenever averages were computed, the figures were truncated instead of being rounded to the nearest number. Thus, the totals in such cases will not equal 100 percent. While 641 Jurisdictions were surveyed, not all summaries and correlations show this total since officials of some communities were not able to provide all the information requested. This absence of data for some communities also affects the projection of the United States totals.

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TABLE E-1—SUMMARY OF POPULATION OF COMMUNITIES WITH COMBINED SEWERS BY POPULATION GROUP AND TYPES OF SYSTEMS

Population Group	Separate Sanitary Sewer System				Separate Storm Sewer System				Combined Sewer System				Unsewered				Total[1]			
	No. Reporting	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group	No. Reporting	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group	No. Reporting	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group	No. Reporting	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group	No. Reporting	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group
U. S. TOTALS—SURVEYED																				
0-500	2	0	0	0	2	0	0	0	2	560	280	83	2	112	56	16	2	672	336	0
501-1,000	12	1,200	100	11	11	600	55	5	12	7,677	640	71	12	1,905	159	17	12	10,782	898	0
1,001-5,000	115	110,399	960	29	111	75,869	684	20	118	230,404	1,953	62	117	29,606	253	7	124	370,409	2,987	0
5,001-10,000	87	239,874	2,757	36	82	171,178	2,088	25	89	361,401	4,061	54	94	60,749	646	9	96	662,024	6,896	1
10,001-25,000	95	584,716	6,155	37	87	350,709	4,031	22	95	895,337	9,425	57	96	82,689	861	5	97	1,562,742	16,111	3
25,001-50,000	115	1,748,361	15,203	41	108	1,223,772	11,331	28	115	2,249,649	19,562	53	118	242,350	2,054	5	120	4,240,360	35,336	8
50,001-100,000	80	2,131,668	26,646	37	77	1,335,966	17,350	23	81	3,361,974	41,506	58	89	222,984	2,505	3	86	5,716,626	66,472	11
100,001-500,000	56	3,738,073	66,751	35	56	2,548,815	45,515	23	55	6,322,781	114,960	59	62	565,691	9,124	5	56	10,626,545	189,760	22
500,001- & Over	21	6,870,443	327,164	27	22	3,587,750	163,080	14	18	17,433,390	968,522	70	23	368,332	16,014	1	19	24,672,165	1,298,535	51
Total	583	15,424,734	26,458	32	556	9,294,659	16,717	19	585	30,863,173[2]	52,758	64	613	1,574,418	2,568	3	612	47,862,325	78,206	100
U. S. TOTALS—PROJECTED																				
0-500	50	0	0	0	50	0	0	0	50	14,000	280	83	50	2,800	56	16	50	16,800	336	0
501-1,000	111	11,100	100	11	101	5,550	55	5	111	71,012	640	71	111	17,621	159	17	111	99,733	898	0
1,001-5,000	424	407,764	962	29	409	280,225	685	20	435	851,008	1,956	62	432	109,351	253	7	458	1,368,123	2,987	2
5,001-10,000	204	564,703	2,768	36	193	402,981	2,088	25	209	850,798	4,071	54	221	143,013	647	9	226	1,558,514	6,896	3
10,001-25,000	197	1,218,158	6,184	37	181	730,643	4,037	22	197	1,865,285	9,468	57	200	172,268	861	5	202	3,255,711	16,117	6
25,001-50,000	115	1,748,361	15,203	41	108	1,223,772	11,331	28	115	2,249,649	19,562	53	118	242,350	2,054	5	120	4,240,360	35,336	8
50,001-100,000	80	2,131,668	26,646	37	77	1,335,966	17,350	23	81	3,361,974	41,506	58	89	222,984	2,505	3	86	5,716,626	66,472	11
100,001-500,000	56	3,738,073	66,751	35	56	2,548,815	45,515	23	55	6,322,781	114,960	59	62	565,691	9,124	5	56	10,626,545	189,760	20
500,001- & Over	21	6,870,443	327,164	27	22	3,587,750	163,080	14	18	17,433,390	968,522	70	23	368,332	16,014	1	19	24,672,165	1,298,535	47
Total	1,258	16,690,270	13,267	32	1,197	10,115,702	8,451	19	1,271	33,019,897[2]	25,979	64	1,306	1,844,410	1,412	3	1,328	51,554,577	38,821	100

[1] Total includes only separate sanitary, combined, and unsewered population figures. The figures for communities reporting only their total population were not included.

[2] Adjustment for communities not reporting would increase the surveyed figure to 34,080,094 and the projected figure to 36,236,006.

TABEL E-2—SUMMARY OF AREA (ACRES) SERVED IN COMMUNITIES WITH COMBINED SEWERS BY POPULATION GROUP AND TYPES OF SYSTEMS

Population Group	Separate Sanitary Sewer System				Separate Storm Sewer System				Combined Sewer System				Unsewered				Total[1]			
	No. Re-port-ing	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group	No. Re-port-ing	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group	No. Re-port-ing	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group	No. Re-port-ing	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group	No. Re-port-ing	Total for Pop. Group	Average for Pop. Group	% of Total for Pop. Group
		(Acres)	(Acres)			(Acres)	(Acres)			(Acres)	(Acres)			(Acres)	(Acres)			(Acres)	(Acres)	
U. S. TOTALS—SURVEYED																				
0-500	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	10	550	55	9	10	550	55	9	10	3,692	369	64	10	1,456	146	25	10	5,698	570	0
1,001-5,000	107	27,240	255	14	105	17,625	168	9	102	61,491	603	32	101	99,597	986	52	103	188,328	1,828	2
5,001-10,000	86	55,309	643	16	82	41,781	510	12	86	75,535	878	23	89	197,481	2,219	60	93	328,325	3,530	5
10,001-25,000	95	129,328	1,361	27	90	95,890	1,065	20	94	159,853	1,701	33	94	189,439	2,015	39	95	478,620	5,038	7
25,001-50,000	114	288,874	2,534	28	110	185,863	1,690	18	115	283,261	2,463	27	116	448,909	3,870	43	119	1,021,044	8,580	16
50,001-100,000	80	435,476	5,443	41	78	314,116	4,027	29	80	418,124	5,227	39	87	194,100	2,231	18	85	1,047,700	12,326	16
100,001-500,000	59	560,532	9,501	34	62	365,025	5,888	22	58	565,408	9,748	34	62	506,892	8,176	31	56	1,632,832	29,158	25
500,001- & Over	22	590,650	26,848	36	23	308,730	13,423	19	20	780,682	39,034	48	23	246,147	10,702	15	19	1,617,479	85,130	25
Total	575	2,087,959	3,631	33	562	1,329,580	2,366	21	565	2,348,046[2]	4,156	37	582	1,884,021	3,237	29	580	6,320,026	10,897	100
U. S. TOTALS—PROJECTED																				
0-500	50	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	92	5,087	55	9	92	5,087	55	9	92	34,151	371	64	92	13,468	146	25	92	52,706	573	0
1,001-5,000	395	100,612	255	14	387	65,098	168	9	376	227,119	604	32	373	367,866	986	52	380	695,597	1,831	8
5,001-10,000	202	130,206	645	16	193	98,359	510	12	202	177,821	880	23	209	464,903	2,224	60	218	772,930	3,546	9
10,001-25,000	197	269,433	1,368	27	187	199,770	1,068	20	195	333,027	1,708	33	195	394,664	2,024	39	197	997,124	5,062	12
25,001-50,000	114	288,874	2,534	28	110	185,863	1,690	18	115	283,261	2,463	27	116	448,909	3,870	43	119	1,021,044	8,580	13
50,001-100,000	80	435,476	5,443	41	78	314,116	4,027	29	80	418,124	5,227	39	87	194,100	2,231	18	85	1,047,700	12,326	13
100,001-500,000	59	560,532	9,501	34	62	365,025	5,888	22	58	565,408	9,748	34	62	506,892	8,176	31	56	1,632,832	29,158	20
500,001- & Over	22	590,650	26,848	36	23	308,730	13,423	19	20	780,682	39,034	48	23	246,147	10,702	15	19	1,617,479	85,130	20
Total	1,211	2,380,870	1,966	30	1,182	1,542,048	1,305	19	1,138	2,819,593[2]	2,478	35	1,157	2,636,949	2,279	33	1,166	7,837,412	6,722	100

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[1] Total includes only area reported as served by separate sanitary, combined sewers, or as unsewered.

[2] A total of 32 communities did not report any information as to area, and 18 reported only partial information. Adjusting for this would increase the surveyed total figure to approximately 2,557,000 and the projected total to 3,029,000.

TABLE E-3—SUMMARY OF MILES OF COLLECTOR SEWERS BY TYPES AND POPULATION GROUP IN JURISDICTIONS WITH COMBINED SEWERS

	Separate Sanitary Sewer System				Separate Storm Sewer System				Combined Sewer System				Total			
Pop. Group	No. Reporting	Total for Pop. Group (Miles)	Average for Pop. Group (Miles)	% of Total for Pop. Group	No. Reporting	Total for Pop. Group (Miles)	Average for Pop. Group (Miles)	% of Total for Pop. Group	No. Reporting	Total for Pop. Group (Miles)	Average for Pop. Group (Miles)	% of Total for Pop. Group	No. Reporting	Total for Pop. Group (Miles)	Average for Pop. Group (Miles)	% of Total for Pop. Group
U. S. TOTALS—SURVEYED																
0-500	2	0	0	0	2	0	0	0	2	1	1	100	2	1	1	0
501-1,000	12	6	1	10	11	2	0	3	11	48	4	85	11	56	5	0
1,001-5,000	103	393	4	29	103	153	1	11	96	772	8	58	93	1,318	14	1
5,001-10,000	80	975	12	34	81	545	7	19	81	1,274	16	45	79	2,794	35	2
10,001-25,000	92	2,136	23	37	88	1,072	12	18	90	2,540	28	44	90	5,748	64	5
25,001-50,000	112	4,316	39	34	111	2,588	23	20	112	5,761	51	45	110	12,665	115	11
50,001-100,000	79	5,212	66	32	82	2,785	34	17	80	8,176	102	50	81	16,173	200	14
100,001-500,000	65	9,354	144	37	62	3,827	62	15	63	11,436	182	46	65	24,617	379	22
500,001 & Over	25	18,414	737	40	24	5,419	226	11	23	21,521	936	47	26	45,354	1,744	41
Total	570	40,806	72	37	564	16,391	29	15	558	51,529	92	47	557	108,726	195	100
U. S. TOTALS—PROJECTED																
0-500	50	0	0	0	50	0	0	0	50	25	1	100	50	25	1	0
501-1,000	111	56	0	10	101	18	0	3	101	444	4	85	101	517	5	0
1,001-5,000	380	1,451	4	29	380	565	1	11	354	2,851	8	58	343	4,867	14	3
5,001-10,000	188	2,295	12	34	190	1,283	7	19	190	2,999	16	45	185	6,577	36	5
10,001-25,000	191	4,450	23	37	183	2,233	12	18	187	5,291	28	44	187	11,974	64	9
25,001-50,000	112	4,316	39	34	111	2,588	23	20	112	5,761	51	45	110	12,665	115	10
50,001-100,000	79	5,212	66	32	82	2,785	34	17	80	8,176	102	50	81	16,173	200	13
100,001-500,000	65	9,354	144	37	62	3,827	62	15	63	11,436	182	46	65	24,617	379	20
500,001 & Over	25	18,414	737	40	24	5,419	226	11	23	21,521	936	47	26	45,354	1,744	36
Total	1,201	45,547	38	37	1,183	18,718	16	15	1,160	58,504	50	47	1,148	122,769	107	100

TABLE E-4—SUMMARY OF MILES OF INTERCEPTOR SEWERS BY TYPES AND POPULATION GROUP IN JURISDICTIONS WITH COMBINED SEWERS

	Separate Sanitary Sewer System				Separate Storm Sewer System				Combined Sewer System				Total			
Pop. Group	No. Re-porting	Total for Pop. Group (Miles)	Average for Pop. Group (Miles)	% of Total for Pop. Group	No. Re-porting	Total for Pop. Group (Miles)	Average for Pop. Group (Miles)	% of Total for Pop. Group	No. Re-porting	Total for Pop. Group (Miles)	Average for Pop. Group (Miles)	% of Total for Pop. Group	No. Re-porting	Total for Pop. Group (Miles)	Average for Pop. Group (Miles)	% of Total for Pop. Group
U. S. TOTALS—SURVEYED																
0-500	2	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0
501-1,000	12	0	0	0	12	0	0	0	12	1	0	100	12	1	0	0
1,001-5,000	119	20	0	15	117	4	0	3	116	105	1	81	114	129	1	1
5,001-10,000	90	91	1	33	90	39	0	14	93	139	1	51	93	269	3	3
10,001-25,000	93	124	1	31	91	34	0	8	90	238	3	60	89	396	4	5
25,001-50,000	115	431	4	37	114	139	1	12	115	582	5	50	115	1,152	10	15
50,001-100,000	90	488	5	40	87	161	2	13	84	567	7	46	82	1,216	15	15
100,001-500,000	65	776	12	40	65	249	4	13	65	868	13	45	67	1,893	28	24
500,001 & Over	24	1,550	65	59	24	134	6	5	24	906	38	34	25	2,590	104	33
Total	610	3,480	6	45	602	760	1	9	601	3,406	6	44	599	7,646	13	100
U. S. TOTALS—PROJECTED																
0-500	50	0	0	0	50	0	0	0	50	0	0	0	50	0	0	0
501-1,000	111	0	0	0	111	0	0	0	111	9	0	100	111	9	0	0
1,001-5,000	439	73	0	15	432	14	0	2	428	387	1	81	421	474	1	5
5,001-10,000	211	214	1	33	211	91	0	14	218	327	2	51	218	632	3	7
10,001-25,000	193	258	1	31	189	70	0	8	187	495	3	60	185	823	4	9
25,001-50,000	115	431	4	37	114	139	1	12	115	582	5	50	115	1,152	10	13
50,001-100,000	90	488	5	40	87	161	2	13	84	567	7	46	82	1,216	15	13
100,001-500,000	65	776	12	40	65	249	4	13	65	868	13	45	67	1,893	28	21
500,001 & Over	24	1,550	65	59	24	134	6	5	24	906	38	34	25	2,590	104	29
Total	1,298	3,790	3	43	1,283	858	1	9	1,282	4,141	3	47	1,274	8,769	7	100

TABLE E-5—SUMMARY OF NUMBER OF OVERFLOWS BY SOURCES AND POPULATION GROUP IN JURISDICTIONS WITH COMBINED SEWERS

Pop. Group	No. of Jurisdictions	Combined Sewers		Treatment Plant Bypass		Pumping Stations				Not Otherwise Identified		Total Overflows
						Combined		Separate				
		No. Reporting	No. Overflows	No. Reporting	No. Overflows	No. Reporting	No. Overflows	No. Reporting	No. Overflows	No. Reporting	No. Overflows	
U. S. TOTALS—SURVEYED												
0-500	2	1	3	0	0	0	0	0	0	1	1	4
501-1,000	12	7	24	1	1	0	0	0	0	4	86	111
1,001-5,000	124	92	471	61	65	37	84	17	25	19	257	902
5,001-10,000	97	74	457	66	73	36	73	17	38	13	160	801
10,001-25,000	98	81	849	75	86	42	103	25	62	8	76	1,176
25,001-50,000	120	84	1,105	68	89	40	144	36	90	15	135	1,563
50,001-100,000	91	67	1,336	52	58	34	101	24	80	8	103	1,678
100,001-500,000	69	62	2,045	44	77	33	127	29	241	12	113	2,603
500,001 & Over	26	25	3,570	21	135	15	127	12	219	7	1,375	5,426
Total	641	493	9,860	388	584	237	759	160	755	87	2,306	14,264
U. S. TOTALS—PROJECTED												
0-500	50	25	75	0	0	0	0	0	0	25	25	100
501-1,000	111	64	222	9	9	0	0	0	0	37	795	1,026
1,001-5,000	458	339	1,739	225	240	136	310	62	92	70	949	3,331
5,001-10,000	228	174	1,075	155	171	84	171	40	89	30	376	1,885
10,001-25,000	204	168	1,768	156	179	87	214	52	129	16	158	2,450
25,001-50,000	120	84	1,105	68	89	40	144	36	90	15	135	1,563
50,001-100,000	91	67	1,336	52	58	34	101	24	80	8	103	1,678
100,001-500,000	69	62	2,045	44	77	33	127	29	241	12	113	2,603
500,001 & Over	28	25	3,570	21	135	15	127	12	219	7	1,375	5,426
Total	1,359	1,008	12,935	730	958	429	1,194	255	940	220	4,029	20,062

[1] Total includes 1329 communities and 30 jurisdictions with overlapping districts.

TABLE E-6—SUMMARY OF CORRELATIONS OF OVERFLOWS AND DISCHARGES BY POPULATION GROUP IN JURISDICTIONS WITH COMBINED SEWERS[1]

		Number of Combined Sewer Overflows				Pumping Station Bypasses								Total Overflows and Discharges	
						on Combined Sewers				on Separate Sewers					
Pop. Group	No. of Jurisdictions	/1000 Acres	/1000 Pop.	/Mile Collector Sewer	/Mile Interceptor Sewer	/1000 Acres	/1000 Pop.	/Mile Collector Sewer	/Mile Interceptor Sewer	/1000 Acres	/1000 Pop.	/Mile Collector Sewer	/Mile Interceptor Sewer	/1000 Total Acres	/1000 Total Pop.
U. S. TOTALS—SURVEYED															
0-500	2	0.000	5.357	3.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	7.143
501-1,000	12	6.501	3.126	0 50	24.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	26.167	12.504
1,001-5,000	124	7.660	2.044	0.61	4.49	1.366	0.365	0.11	0.80	1.418	0.330	0.16	6.25	10.166	2.647
5,001-10,000	97	6.148	1.265	0.36	3.29	0.982	0.202	0.06	0.53	0.910	0.222	0.07	0.97	6.178	1.332
10,001-25,000	98	5.311	0.948	0.33	3.57	0.644	0.115	0.04	0.43	0.647	0.177	0.06	1.82	4.067	0.795
25,001-50,000	120	3.904	0.437	0.19	1.90	0.509	0.057	0.02	0.25	0.489	0.077	0.03	0.65	2.740	0.374
50,001-100,000	91	3.195	0.397	0.16	2.36	0.242	0.030	0.01	0.18	0.255	0.053	0.03	0.50	1.966	0.296
100,001-500,000	69	3.644	0.321	0.18	2.36	0.226	0.020	0.01	0.15	0.649	0.093	0.06	0.97	2.325	0.257
500,001 & Over	28	4.817	0.205	0.17	3.94	0.171	0.007	0.01	0.14	0.709	0.061	0.04	1.63	4.074	0.223
Total	641	4.282	0.316	0.19	2.89	0.330	0.024	0.01	0.22	0.566	0.080	0.05	0.99	3.252	0.305
U. S. TOTALS—PROJECTED															
0-500	50	0.000	5.357	3.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	7.143
501-1,000	111	6.501	3.126	0.50	24.67	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	26.148	12.495
1,001-5,000	458	7.657	2.043	0.61	4.49	1.365	0.364	0.11	0.80	1.413	0.328	0.16	6.57	10.164	2.646
5,001-10,000	228	6.143	1.264	0.36	3.29	0.977	0.201	0.06	0.52	0.905	0.221	0.07	0.98	6.176	1.332
10,001-25,000	204	5.309	0.948	0.33	3.57	0.643	0.115	0.04	0.43	0.646	0.177	0.06	1.84	4.067	0.795
25,001-50,000	120	3.904	0.437	0.19	1.90	0.509	0.057	0.02	0.25	0.489	0.077	0.03	0.65	2.740	0.374
50,001-100,000	91	3.195	0.397	0.16	2.36	0.242	0.030	0.01	0.18	0.255	0.053	0.03	0.50	1.966	0.296
100,001-500,000	69	3.644	0.321	0.18	2.36	0.226	0.020	0.01	0.15	0.649	0.093	0.06	0.97	2.325	0.257
500,001 & Over	28	4.817	0.205	0.17	3.94	0.171	0.007	0.01	0.14	0.709	0.061	0.04	1.63	4.074	0.223
Total	1,359	4.665	0.388	0.22	3.12	0.431	0.036	0.02	0.29	0.608	0.091	0.05	1.10	3,896	0.400

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[1] All Correlations are based on area and population served by combined sewers and miles of combined collector or interceptor sewers except as noted.

TABLE E-7—SUMMARY OF METHODS REPORTEDLY USED FOR TREATMENT AND CONTROL OF COMBINED SEWER OVERFLOWS AND AVAILABILITY OF OPERATING REPORTS BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	No. Reporting	Screening			Disinfection			Sedimentation			In-System Storage			Off-System Storage			Chemical Treatment			Automated Regulator			Sewer[1] Separation			Other			Total
			No. Installations	Reports Available Y	N	No. Installations	Reports Available Y	N	No. Installations	Reports Available Y	N	No. Installations	Reports Available Y	N	No. Installations	Reports Available Y	N	No. Installations	Reports Available Y	N	No. Installations	Reports Available Y	N	No. Installations	Reports Available Y	N	No. Installations	Reports Available Y	N	No. Installations
U. S. TOTALS—SURVEYED																														
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	124	24	9	2	4	7	2	1	1	1	0	3	1	2	0	0	0	0	0	0	0	0	0	44	4	12	1	1	0	66
5,001-10,000	97	29	6	3	3	3	3	0	2	1	1	7	0	4	1	0	1	3	0	1	2	0	2	105	6	10	6	1	0	135
10,001-25,000	98	31	16	3	2	8	7	1	5	2	2	10	3	3	3	1	2	3	1	2	4	2	1	159	9	13	1	0	1	209
25,001-50,000	120	37	41	6	4	4	2	1	7	2	1	5	1	2	10	1	2	2	1	0	11	1	2	336	11	13	2	1	0	418
50,001-100,000	91	25	10	3	3	1	1	0	1	0	1	4	1	2	0	0	0	0	0	0	4	2	0	192	9	8	0	0	0	212
100,001-500,000	69	32	49	4	1	4	3	0	1	1	0	26	3	2	4	0	3	1	0	1	40	1	1	809	5	15	13	1	2	947
500,001 & Over	28	15	62	2	1	11	1	1	1	0	1	83	2	2	4	2	1	0	0	0	44	1	2	130	3	5	0	0	0	335
Total	641	193	193	23	18	38	19	4	18	7	6	138	11	17	22	4	9	9	2	4	105	7	8	1,775	47	76	23	4	3	2,321
U. S. TOTALS—PROJECTED																														
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	458	88	33	7	14	25	7	3	3	3	0	11	3	7	0	0	0	0	0	0	0	0	0	162	14	44	3	3	0	240
5,001-10,000	228	68	14	7	7	7	7	0	4	2	2	16	0	9	2	0	2	7	0	2	4	0	4	247	14	23	14	2	0	317
10,001-25,000	204	64	33	6	4	16	14	2	10	4	4	20	6	6	6	2	4	6	2	4	8	4	2	331	18	27	2	0	2	435
25,001-50,000	120	37	41	6	4	4	2	1	7	2	1	5	1	2	10	1	2	2	1	0	11	1	2	336	11	13	2	1	0	418
50,001-100,000	91	25	10	3	3	1	1	0	1	0	1	4	1	2	0	0	0	0	0	0	4	2	0	192	9	8	0	0	0	212
100,001-500,000	69	32	49	4	1	4	3	0	1	1	0	26	3	2	4	0	3	1	0	1	40	1	1	809	5	15	13	1	2	947
500,001 & Over	28	15	62	2	1	11	1	1	1	0	1	83	2	2	4	2	1	0	0	0	44	1	2	130	3	5	0	0	0	335
Total	1,359	329	242	35	34	68	35	7	27	12	9	165	16	30	26	5	12	16	3	7	111	9	11	2,207	74	135	34	7	4	2,904

[1] Any Size Project.

TABLE E-8—SUMMARY OF SEWER COLLECTION SYSTEM REGULATORS REPORTEDLY IN USE IN JURISDICTIONS WITH COMBINED SEWERS BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	No. Reporting	Floating Gate		Tipping Gate		Hydraulic Cylinder		Leaping Weir		Side Weir		Perpendicular Weir		Manual or Automatic Valve		Drop Inlet		Not Otherwise Identified		Total No. Regulators
			No. Installations	Performance[1]	No. Installations	Performance[1]	No. Installations	Performance[1]	No. Installations	Performance[1]	No. Installations	Performance[1]	No. Installations	Performance[1]	No. Installations	Performance[1]	No. Installations	Performance[1]	No. Installations	Performance[1]	
U. S. TOTALS—SURVEYED																					
0-500	2	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
501-1,000	12	1	0	0.0	0	0.0	0	0.0	0	0.0	3	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3
1,001-5,000	124	72	26	3.9	9	3.0	0	0.0	21	4.6	72	2.4	85	2.1	18	1.3	52	3.3	67	2.3	350
5,001-10,000	97	73	21	2.5	26	3.3	0	0.0	28	3.6	82	2.2	87	1.8	87	1.6	87	3.5	58	1.3	476
10,001-25,000	98	74	80	3.9	13	4.2	0	0.0	71	2.5	125	1.7	247	2.3	41	2.8	14	3.0	75	1.6	666
25,001-50,000	120	87	161	3.2	58	3.0	6	2.5	122	2.4	229	2.3	260	2.5	50	2.9	131	4.2	149	1.4	1,166
50,001-100,000	91	66	168	4.6	20	2.0	0	0.0	116	2.7	246	2.2	432	3.0	70	2.6	53	2.7	293	3.0	1,398
100,001-500,000	69	64	575	4.6	26	4.0	29	3.3	211	2.9	303	1.9	488	3.2	104	3.5	527	4.1	113	3.3	2,376
500,001 & Over	28	26	325	4.5	353	4.3	33	4.0	616	3.4	824	2.6	434	2.6	46	2.6	205	2.9	754	3.4	3,590
Total	641	463	1,356	4.1	505	3.5	68	3.3	1,185	2.9	1,884	2.1	2,033	2.5	416	2.6	1,069	3.5	1,509	2.2	10,025
U. S. TOTALS—PROJECTED																					
0-500	50	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
501-1,000	111	9	0	0.0	0	0.0	0	0.0	0	0.0	27	0.0	0	0.0	0	0.0	0	0.0	0	0.0	27
1,001-5,000	458	265	96	3.9	33	3.7	0	0.0	77	4.7	265	2.4	313	2.1	66	1.3	192	3.3	247	2.3	1,292
5,001-10,000	228	171	49	2.6	61	3.3	0	0.0	65	3.6	193	2.2	204	1.8	204	1.6	204	3.5	136	1.3	1,120
10,001-25,000	204	154	166	3.9	27	4.3	0	0.0	147	2.5	260	1.7	514	2.3	85	2.8	29	3.1	156	1.6	1,387
25,001-50,000	120	87	161	3.2	58	3.0	6	2.5	122	2.4	229	2.3	260	2.5	50	2.9	131	4.2	149	1.4	1,166
50,001-100,000	91	66	168	4.6	20	2.0	0	0.0	116	2.7	246	2.2	432	3.0	70	2.6	53	2.7	293	3.0	1,398
100,001-500,000	69	64	575	4.6	26	4.0	29	3.3	211	2.9	303	1.9	488	3.2	104	3.5	527	4.1	113	3.3	2,376
500,001 & Over	28	26	325	4.5	353	4.3	33	4.0	616	3.4	824	2.6	434	2.6	46	2.6	205	2.9	754	3.4	3,590
Total	1,359	842	1,540	4.0	578	3.6	68	3.3	1,354	3.1	2,347	2.1	2,645	2.3	625	2.3	1,341	3.5	1,848	2.1	12,356

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[1] Performance Rating—Ranging from 1 meaning no operational problems to 9 meaning always giving difficulties.

TABLE E-9—SUMMARY OF OVERFLOW MONITORING PRACTICES AND MAINTENANCE COST OF REGULATORS BY POPULATION GROUP

Population Group	Number of Jurisdictions	Overflow Monitoring						Cost of Regulator Maintenance	
		Quantity		Quality		Reports Available			
		Yes	No	Yes	No	Yes	No	Number Reporting	Average Annual Maintenance Cost
U. S. TOTALS—SURVEYED									
0-500	2	0	1	0	1	0	1	0	0
501-1,000	12	0	6	0	6	0	6	0	0
1,001-5,000	124	10	84	6	88	6	78	17	225
5,001-10,000	97	6	71	3	74	1	64	24	553
10,001-25,000	98	8	76	5	79	5	72	27	1,250
25,001-50,000	120	9	94	10	93	10	78	32	9,194
50,001-100,000	91	11	65	13	64	11	58	28	15,813
100,001-500,000	69	12	55	10	57	10	48	30	14,177
500,001 & Over	28	5	22	7	20	6	20	15	52,561
Total	641	61	474	54	482	49	425	173	11,569
U. S. TOTALS—PROJECTED									
0-500	50	0	25	0	25	0	25	0	0
501-1,000	111	0	55	0	55	0	55	0	0
1,001-5,000	458	36	310	22	325	22	288	62	227
5,001-10,000	228	14	167	7	174	2	150	56	558
10,001-25,000	204	16	158	10	164	10	150	56	1,256
25,001-50,000	120	9	94	10	93	10	78	32	9,194
50,001-100,000	91	11	65	13	64	11	58	28	15,813
100,001-500,000	69	12	55	10	57	10	48	30	14,177
500,001 & Over	28	5	22	7	20	6	20	15	52,561
Total	1,359	103	951	79	977	71	872	279	7,406

TABLE E-10—SUMMARY OF DATA CONCERNING REGULATORS, OVERFLOWS AND INFILTRATION BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Frequency of Regulator Inspection					Is There Routine Regulator Maintenance?			Dry Weather Overflows									Does Infiltration Occur In						Does Infiltration Exceed Design or Code?		
										Occur		Due to Regulators			Due to Sewer Capacity			Dry Weather			Wet Weather					
		Wkly.	After Storm	Bi-wkly.	Monthly	Other	Yes	No	Don't Know	Yes	No	Yes	No	Don't Know	Yes	No	Don't Know	Yes	No	Don't Know	Yes	No	Don't Know	Yes	No	Don't Know
U. S. TOTALS—SURVEYED																										
0-500	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
501-1,000	12	0	1	0	0	0	0	2	0	1	1	0	1	0	1	0	0	3	7	1	4	5	1	0	1	8
1,001-5,000	124	14	19	9	14	14	44	28	0	9	67	2	6	0	6	4	0	16	94	9	54	56	10	17	32	60
5,001-10,000	97	19	22	4	10	21	43	28	0	12	60	5	9	0	6	6	0	10	80	1	49	44	3	23	39	26
10,001-25,000	98	19	22	6	14	16	50	28	0	12	64	3	9	1	6	8	1	14	80	1	51	42	4	27	33	32
25,001-50,000	120	18	23	9	13	20	68	18	0	14	80	6	5	1	7	9	1	18	92	2	64	47	4	38	36	35
50,001-100,000	91	17	16	6	6	16	42	25	0	16	56	9	10	0	8	9	0	10	78	0	52	34	4	25	39	22
100,001-500,000	69	23	25	6	10	15	58	7	0	22	43	17	6	0	11	12	0	12	53	2	42	21	3	30	19	16
500,001 & Over	28	11	11	3	1	6	22	3	1	10	15	6	4	0	8	3	0	2	25	0	15	11	0	10	9	7
Total	641	121	139	43	68	108	327	139	1	96	387	48	50	2	53	51	2	85	511	16	331	262	29	170	208	207
U. S. TOTALS—PROJECTED																										
0-500	50	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	50	0	0	50	0	0	0	25
501-1,000	111	0	9	0	0	0	0	18	0	9	9	0	9	0	9	0	0	27	64	9	37	46	9	0	9	74
1,001-5,000	458	51	70	33	51	51	162	103	0	33	247	7	22	0	22	14	0	59	347	33	199	206	36	62	118	221
5,001-10,000	228	44	51	9	23	49	101	65	0	28	141	11	21	0	14	14	0	23	188	2	115	103	7	54	91	61
10,001-25,000	204	39	45	12	29	33	104	58	0	25	133	6	18	2	12	16	2	29	166	2	108	87	8	56	68	66
25,001-50,000	120	18	23	9	13	20	68	18	0	14	80	6	5	1	7	9	1	18	92	2	64	47	4	38	36	35
50,001-100,000	91	17	16	6	6	16	42	25	0	16	56	9	10	0	8	9	0	10	78	0	52	34	4	25	39	22
100,001-500,000	69	23	25	6	10	15	58	7	0	22	43	17	6	0	11	12	0	12	53	2	42	21	3	30	19	16
500,001 & Over	28	11	11	3	1	6	22	3	1	10	15	6	4	0	8	3	0	2	25	0	15	11	0	10	9	7
Total	1,359	203	250	78	133	190	567	297	1	157	749	62	95	3	91	77	3	180	1063	50	630	605	71	275	389	527

TABLE E-11—SUMMARY OF ENGINEERING STUDIES AND COST ESTIMATES OF COMBINED SEWER SEPARATION BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Have Engineering Studies Been Made?		Have Cost Estimates Been Made?		Engineering Study Estimated Cost for Sewer Separation or Alternate Methods								Reports Available	
								Estimate of Cost of Complete Separation		Cost /Acre Served By Combined Sewer	Cost /Capita Served By Combined Sewer	Estimated Cost of Complete Separation			
		Yes	No	Yes	No	Cost	Average Cost	Cost	Average Cost			/Acre Served By Combined Sewer	/Capita Served By Combined Sewer	Yes	No
U. S. TOTALS—SURVEYED															
0-500	2	0	2	0	1	0	0	0	0	0	0	0	0	0	1
501-1,000	12	8	4	6	2	1,266,000	211,000	804,000	160,800	342	164	217	104	5	0
1,001-5,000	124	46	78	29	63	14,450,630	498,297	19,535,453	1,395,389	235	62	317	84	14	57
5,001-10,000	97	50	45	35	42	29,931,057	855,173	25,774,259	1,356,539	402	82	346	71	19	43
10,001-25,000	98	46	52	34	42	82,342,400	2,421,835	136,346,420	7,176,127	515	91	852	152	19	49
25,001-50,000	120	61	59	42	59	143,673,002	3,420,785	324,665,000	17,087,631	507	56	1,146	128	19	65
50,001-100,000	91	42	49	32	47	339,579,101	10,611,846	464,681,100	27,334,182	812	101	1,111	138	17	50
100,001-500,000	69	41	29	30	25	1,261,873,600	42,062,453	1,874,058,000	93,702,900	2,248	198	3,339	294	20	34
500,001 & Over	28	16	11	12	10	1,609,261,000	134,105,083	10,055,352,395	1,436,478,912	2,171	92	13,568	576	7	15
Total	641	310	329	220	291	3,482,376,790	15,828,985	12,901,216,627	107,510,138	1,512	111	5,602	413	120	314
U. S. TOTALS—PROJECTED															
0-500	50	0	50	0	25	0	0	0	0	0	0	0	0	0	25
501-1,000	111	74	37	55	18	11,710,500	212,918	7,437,000	161,673	342	164	217	104	46	0
1,001-5,000	458	169	288	107	232	53,374,100	498,823	72,155,140	1,414,806	235	62	317	84	51	210
5,001-10,000	228	117	105	82	98	70,462,696	859,301	60,676,901	1,379,020	402	82	346	71	44	101
10,001-25,000	204	95	108	70	87	171,546,666	2,450,666	284,055,040	7,283,462	515	91	852	152	39	102
25,001-50,000	120	61	59	42	59	143,673,002	3,420,785	324,665,000	17,087,631	507	56	1,146	128	19	65
50,001-100,000	91	42	49	32	47	339,579,100	10,611,846	464,681,100	27,334,182	812	101	1,111	138	17	50
100,001-500,000	69	41	29	30	25	1,261,873,600	42,062,453	1,874,058,000	93,702,900	2,248	198	3,339	294	20	34
500,001 & Over	28	16	11	12	10	1,609,260,992	134,105,082	10,055,352,192	1,436,478,880	2,171	92	13,568	576	7	15
Total	1,359	615	736	430	601	3,661,480,656	8,515,071	13,143,080,373	54,086,750	1,320	109	4,740	394	243	602

TABLE E-12—SUMMARY OF CURRENT PLANS FOR SEWER SEPARATION, TREATMENT OR CONTROL OF COMBINED SEWER OVERFLOWS OR OTHER DISCHARGES BY POPULATION GROUP OR STORM WATER OVERFLOWS

		Plans for Sewer Separation[1]				Plans for Alternate Means				Sewer Separation		Alternate Means	
Pop. Group	No. of Jurisdictions	Yes	No.	Cost	Average Cost	Yes	No	Cost	Average Cost	$/Acre[2] Served By Combined Sewer	$/Pop.[2] Served By Combined Sewer	$/Acre[2] Served By Combined Sewer	$/Pop.[2] Served By Combined Sewer
U. S. TOTALS—SURVEYED													
0-500	2	0	2	0	0	0	2	0	0	0	0	0	0
501-1,000	12	5	6	510,000	102,000	2	8	0	0	138	66	0	0
1,001-5,000	124	35	82	12,818,455	366,241	3	89	1,346,132	448,710	208	55	21	5
5,001-10,000	97	33	59	13,506,457	409,286	3	71	30,000	10,000	181	37	0	0
10,001-25,000	98	32	61	39,503,604	1,234,487	4	74	11,750,000	2,937,500	247	44	73	13
25,001-50,000	120	48	67	101,059,500	2,105,406	9	85	15,875,000	1,763,888	357	40	56	6
50,001-100,000	91	35	50	209,726,680	5,992,190	12	55	24,611,000	2,050,916	501	62	58	7
100,001-500,000	69	25	40	297,275,701	11,891,028	9	47	540,857,901	60,095,322	529	46	963	84
500,001 & Over	28	9	15	155,048,000	17,227,555	10	13	62,313,000	6,231,300	209	8	84	3
Total	641	222	382	829,448,397	3,736,254	52	444	656,783,033	12,630,442	360	26	285	21
U. S. TOTALS—PROJECTED													
0-500	50	0	50	0	0	0	50	0	0	0	0	0	0
501-1,000	111	46	55	4,717,500	102,554	18	74	0	0	138	66	0	0
1,001-5,000	458	129	302	47,345,583	367,020	11	328	4,972,003	452,000	208	55	21	5
5,001-10,000	228	77	138	31,796,450	412,940	7	167	70,625	10,089	181	37	0	0
10,001-25,000	204	66	127	82,299,174	1,246,957	8	154	24,479,166	3,059,895	247	44	73	13
25,001-50,000	120	48	67	101,059,500	2,105,406	9	85	15,875,000	1,763,888	357	40	56	6
50,001-100,000	91	35	50	209,726,680	5,992,190	12	55	24,611,000	2,050,916	501	62	58	7
100,001-500,000	69	25	40	297,275,700	11,891,028	9	47	540,857,896	60,095,321	529	46	963	84
500,001 & Over	28	9	15	155,048,000	17,227,555	10	13	62,313,008	6,231,300	209	8	84	3
Total	1,359	435	844	929,268,587	2,136,249	84	973	673,178,698	8,014,032	335	27	242	20

[1] Any size project.

[2] Based on total area or population served by combined sewers although project may be for less than complete area.

TABLE E-13—SUMMARY OF RESPONSIBILITY FOR COLLECTION AND DISPOSAL OF SEWAGE, AND INDUSTRIAL POPULATION EQUIVALENT BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Jurisdictional Responsibility for Sewer System			Jurisdiction Accept or Discharge Combined Sewage				Industrial Population Equivalent in Combined Sewers		Industrial Population Equivalent in Separate Sanitary		Industrial Population Equivalent at Water Pollution Control Plant	
		Collection System	Disposal System	Partial	Accept from Others Yes	Accept from Others No	Discharge To Others Yes	Discharge To Others No		(1)		(1)		(1)
U. S. TOTALS—SURVEYED														
0-500	2	2	2	0	1	1	1	1	0	0.00	0	0.00	0	0.00
501-1,000	12	10	10	0	1	10	0	11	0	0.00	0	0.00	0	0.00
1,001-5,000	124	117	113	0	1	117	1	117	44,880	0.19	27,580	0.25	400	0.00
5,001-10,000	97	92	88	0	10	85	5	90	196,700	0.54	55,830	0.23	176,000	0.24
10,001-25,000	98	90	86	1	12	83	7	88	164,227	0.18	156,600	0.27	1,125,150	0.70
25,001-50,000	120	109	80	1	21	97	31	87	657,527	0.26	228,200	0.14	816,731	0.19
50,001-100,000	91	82	60	6	23	66	25	63	676,800	0.20	495,100	0.21	1,380,260	0.22
100,001-500,000	69	59	49	9	35	35	18	52	4,556,000	0.72	563,000	0.15	3,327,000	0.27
500,001 & Over	28	21	22	1	16	11	5	22	9,330,000	0.54	885,000	0.13	10,209,874	0.39
Total	641	582	510	18	120	505	93	531	15,626,134	0.50	2,411,310	0.16	17,035,415	0.33
U. S. TOTALS—PROJECTED														
0-500	50	50	50	0	25	25	25	25	0	0.00	0	0.00	0	0.00
501-1,000	111	92	92	0	9	92	0	101	0	0.00	0	0.00	0	0.00
1,001-5,000	458	432	417	0	3	432	3	432	165,766	0.19	101,868	0.25	1,477	0.00
5,001-10,000	228	216	207	0	23	200	11	211	463,064	0.54	131,433	0.23	414,333	0.24
10,001-25,000	204	187	179	2	25	172	14	183	342,139	0.18	326,250	0.27	2,344,062	0.70
25,001-50,000	120	109	80	1	21	97	31	87	657,527	0.26	228,200	0.14	816,731	0.19
50,001-100,000	91	82	60	6	23	66	25	63	676,800	0.20	495,100	0.21	1,380,260	0.22
100,001-500,000	69	59	49	9	35	35	18	52	4,556,000	0.72	563,000	0.15	3,327,000	0.27
500,001 & Over	28	21	22	1	16	11	5	22	9,330,000	0.54	885,000	0.13	10,209,874	0.39
Total	1,359	1,248	1,156	19	180	1,130	132	1,176	16,191,296	0.49	2,730,851	0.16	18,493,737	0.33

Key: (1) Ratio of industrial population equivalent to total population equivalent served by sewer system-computed on the basis of 0.167 lb. B.O.D. per person.

TABLE E-14—SUMMARY OF RESPONSES TO WHETHER OR NOT VARIOUS TYPES OF LOCAL FLOODING OCCUR BY POPULATION GROUP

		Type of Flooding															
		Basement				Manhole Overflows				Underpass				Other			
Pop. Group	No. of Jurisdictions	Yes	No	Percent Yes	Percent of Jurisdiction Affected	Yes	No	Percent Yes	Percent of Jurisdiction Affected	Yes	No	Percent Yes	Percent of Jurisdiction Affected	Yes	No	Percent Yes	Percent of Jurisdiction Affected
U. S. TOTALS—SURVEYED																	
0-500	2	0	2	0	0	0	2	0	0	0	1	0	0	0	0	0	0
501-1,000	12	6	4	60	18	0	9	0	0	1	5	16	0	0	3	0	0
1,001-5,000	124	54	48	52	14	34	61	35	9	6	74	7	1	9	33	21	10
5,001-10,000	97	56	29	65	13	26	54	32	6	7	68	9	1	12	24	33	6
10,001-25,000	98	55	35	61	16	39	52	42	12	8	79	9	1	19	25	43	14
25,001-50,000	120	97	18	84	13	58	49	54	6	27	78	25	1	21	19	52	9
50,001-100,000	91	62	20	75	10	43	37	53	8	25	54	31	12	15	18	45	18
100,001-500,000	69	42	15	73	10	30	25	54	8	29	25	53	1	13	10	56	10
500,001 & Over	28	18	3	85	9	9	11	45	1	11	10	52	12	5	5	50	10
Total	641	390	174	69	13	239	300	44	8	114	394	22	4	94	137	40	12
U. S. TOTALS—PROJECTED																	
0-500	50	0	50	0	0	0	50	0	0	0	25	0	0	0	0	0	0
501-1,000	111	55	37	59	18	0	83	0	0	9	46	16	0	0	27	0	0
1,001-5,000	458	199	177	52	14	125	225	35	9	22	273	7	1	33	121	21	10
5,001-10,000	228	131	68	65	13	61	127	32	6	16	160	9	1	28	56	33	6
10,001-25,000	204	114	72	61	16	81	108	42	12	16	164	8	1	39	52	42	14
25,001-50,000	120	97	18	84	13	58	49	54	6	27	78	25	1	21	19	52	9
50,001-100,000	91	62	20	75	10	43	37	53	8	25	54	31	12	15	18	45	18
100,001-500,000	69	42	15	73	10	30	25	54	8	29	25	53	1	13	10	56	10
500,001 & Over	28	18	3	85	9	9	11	45	1	11	10	52	12	5	5	50	10
Total	1,359	718	460	60	14	407	715	36	8	155	835	15	3	154	308	33	11

TABLE E-15—SUMMARY OF CONSTRUCTION OF SEWERS BY TYPE FOR THE PERIOD 1957-67 IN MILES BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Sewer Construction in the Last 10 Years					
		To Serve New Areas			To Reconstruct Existing Sewers		
		Separate			Separate		
		Sanitary	Storm	Combined	Sanitary	Storm	Combined
U. S. TOTALS—SURVEYED							
0-500	2	0	0	0	0	0	0
501-1,000	12	0	0	4	2	0	0
1,001-5,000	124	142	47	58	34	17	11
5,001-10,000	97	239	122	42	34	45	17
10,001-25,000	98	460	88	105	130	167	30
25,001-50,000	120	1,426	871	154	67	79	37
50,001-100,000	91	1,898	830	175	166	273	116
100,001-500,000	69	2,553	1,189	230	171	214	111
500,001 & Over	28	2,797	1,273	429	8	6	424
Total	641	9,515	4,420	1,197	612	801	746
U. S. TOTALS—PROJECTED							
0-500	50	0	0	0	0	0	0
501-1,000	111	0	0	37	18	0	0
1,001-5,000	458	524	173	214	125	62	40
5,001-10,000	228	562	287	98	80	105	40
10,001-25,000	204	958	183	218	270	347	62
25,001-50,000	120	1,426	871	154	67	79	37
50,001-100,000	91	1,898	830	175	166	273	116
100,001-500,000	69	2,553	1,189	230	171	214	111
500,001 & Over	28	2,797	1,273	429	8	6	424
Total	1,359	10,718	4,806	1,555	905	1,086	830

TABLE E-16A—SUMMARY OF LAND USE CHARACTERISTICS AT OVERFLOW POINTS BY SOURCE OF OVERFLOW AND POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow
AGRICULTURE													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	1	1	100
501-1,000	12	2	9	18	0	0	0	0	0	0	0	0	0
1,001-5,000	124	24	89	18	18	20	31	16	26	24	2	6	1
5,001-10,000	97	14	30	1	19	21	22	9	12	10	0	0	0
10,001-25,000	98	12	28	3	16	19	22	6	23	14	1	2	4
25,001-50,000	120	5	6	0	10	13	13	2	3	1	1	2	1
50,001-100,000	91	5	9	0	10	11	19	6	11	6	1	1	1
100,001-500,000	69	5	33	1	6	10	12	6	77	23	1	26	27
500,001 & Over	28	1	3	0	2	3	2	0	0	0	0	0	0
Total	641	68	207	1	81	97	15	45	152	11	7	38	2
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	25	25	100
501-1,000	111	18	83	18	0	0	0	0	0	0	0	0	0
1,001-5,000	458	88	328	18	66	73	30	59	96	24	7	22	1
5,001-10,000	228	32	70	1	44	49	22	21	28	10	0	0	0
10,001-25,000	204	25	58	3	33	39	22	12	47	14	2	4	4
25,001-50,000	120	5	6	0	10	13	13	2	3	1	1	2	1
50,001-100,000	91	5	9	0	10	11	19	6	11	6	1	1	1
100,001-500,000	69	5	33	1	6	10	12	6	77	23	1	26	27
500,001 & Over	28	1	3	0	2	3	2	0	0	0	0	0	0
Total	1,359	179	590	3	171	198	19	106	262	13	37	80	2
RECREATION													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	124	11	33	6	5	5	7	6	9	8	1	5	0
5,001-10,000	97	12	732	39	5	5	5	3	13	11	1	1	1
10,001-25,000	98	12	47	5	2	2	2	12	15	9	0	0	0
25,001-50,000	120	17	117	11	6	7	7	10	19	8	2	2	1
50,001-100,000	91	20	67	6	2	2	3	6	8	4	0	0	0
100,001-500,000	69	23	222	11	7	13	16	9	24	7	0	0	0
500,001 & Over	28	16	256	7	2	3	2	4	16	6	2	116	51
Total	641	111	1,474	13	29	37	6	50	104	7	6	124	9
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	458	40	121	6	18	18	7	22	33	8	3	18	0
5,001-10,000	228	28	1,723	39	11	11	5	7	30	10	2	2	1
10,001-25,000	204	25	97	5	4	4	2	25	31	9	0	0	0
25,001-50,000	120	17	117	11	6	7	7	10	19	8	2	2	1
50,001-100,000	91	20	67	6	2	2	3	6	8	4	0	0	0
100,001-500,000	69	23	222	11	7	13	16	9	24	7	0	0	0
500,001 & Over	28	16	256	7	2	3	2	4	16	6	2	116	51
Total	1,359	169	2,603	16	50	58	5	83	161	8	9	138	3

TABLE E-16B—SUMMARY OF LAND USE CHARACTERISTICS AT OVERFLOW POINTS BY SOURCE OF OVERFLOW AND POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Report ing	No. Overflow Points	% of Total By Source of Overflow
						RESIDENTIAL							
U. S. TOTALS—SURVEYED													
0-500	2	1	3	100	0	0	0	0	0	0	0	0	0
501-1,000	12	3	5	10	1	1	100	0	0	0	1	55	67
1,001-5,000	124	33	152	31	6	8	12	11	22	20	4	281	49
5,001-10,000	97	35	891	47	7	9	9	15	32	27	4	48	75
10,001-25,000	98	38	308	36	5	5	5	19	42	27	3	13	28
25,001-50,000	120	42	301	29	9	17	18	24	67	31	7	45	29
50,001-100,000	91	30	250	23	7	7	12	17	48	28	1	7	7
100,001-500,000	69	28	315	16	4	5	6	17	66	20	3	19	20
500,001 & Over	28	15	1,036	30	4	23	16	11	133	56	2	68	30
Total	641	226	3,261	30	43	75	12	114	410	31	25	536	40
U. S. TOTALS—PROJECTED													
0-500	50	25	75	100	0	0	0	0	0	0	0	0	0
501-1,000	111	27	46	10	9	9	100	0	0	0	9	508	67
1,001-5,000	458	121	561	31	22	29	12	40	81	20	14	1,037	49
5,001-10,000	228	84	2,097	47	16	21	9	35	75	27	9	113	75
10,001-25,000	204	79	641	36	10	10	5	39	87	27	6	27	28
25,001-50,000	120	42	301	29	9	17	18	24	67	31	7	45	29
50,001-100,000	91	30	250	23	7	7	12	17	48	28	1	7	7
100,001-500,000	69	28	315	16	4	5	6	17	66	20	3	19	20
500,001 & Over	28	15	1,036	30	4	23	16	11	133	56	2	68	30
Total	1,359	451	5,322	33	81	121	11	183	567	28	51	1,824	49
						INDUSTRIAL							
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	1	24	50	0	0	0	0	0	0	0	0	0
1,001-5,000	124	9	31	6	9	9	14	4	6	5	2	12	2
5,001-10,000	97	28	88	4	15	15	16	10	20	16	2	6	9
10,001-25,000	98	34	199	23	23	23	27	18	26	16	2	5	10
25,001-50,000	120	32	260	25	21	22	23	21	57	26	6	32	21
50,001-100,000	91	32	491	45	22	25	43	22	60	36	3	65	73
100,001-500,000	69	37	779	40	19	28	34	17	68	20	4	17	18
500,001 & Over	28	19	1,582	46	14	96	68	11	53	22	3	38	16
Total	641	192	3,454	32	123	218	35	103	290	21	22	175	13
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	9	222	50	0	0	0	0	0	0	0	0	0
1,001-5,000	458	33	114	6	33	33	13	14	22	5	7	44	2
5,001-10,000	228	65	207	4	35	35	16	23	47	16	4	14	9
10,001-25,000	204	70	414	23	47	47	26	37	54	16	4	10	10
25,001-50,000	120	32	260	25	21	22	23	21	57	26	6	32	21
50,001-100,000	91	32	491	45	22	25	43	22	60	36	3	65	73
100,001-500,000	69	37	779	40	19	28	34	17	68	20	4	17	18
500,001 & Over	28	19	1,582	46	14	96	68	11	53	22	3	38	16
Total	1,359	297	4,069	25	191	286	28	145	361	18	31	220	5

TABLE E-16C—SUMMARY OF LAND USE CHARACTERISTICS AT OVERFLOW POINTS BY SOURCE OF OVERFLOW AND POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow
VACANT													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	3	9	18	0	0	0	0	0	0	0	0	0
1,001-5,000	124	30	128	26	17	18	28	12	37	35	4	50	8
5,001-10,000	97	19	66	3	15	29	31	14	24	20	2	4	6
10,001-25,000	98	19	104	12	23	28	32	13	33	21	2	5	10
25,001-50,000	120	23	150	14	22	25	26	13	42	19	1	1	0
50,001-100,000	91	17	145	13	9	9	15	10	24	14	1	10	11
100,001-500,000	69	10	141	7	11	15	18	8	61	18	2	25	26
500,001 & Over	28	7	63	1	3	11	7	3	20	8	0	0	0
Total	641	128	806	7	100	135	21	73	241	18	12	95	7
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	27	83	18	0	0	0	0	0	0	0	0	0
1,001-5,000	458	110	472	26	62	66	27	44	136	35	14	184	8
5,001-10,000	220	44	155	3	35	68	31	32	56	20	4	9	6
10,001-25,000	204	39	216	12	47	58	32	27	68	21	4	10	10
25,001-50,000	120	23	150	14	22	25	26	13	42	19	1	1	0
50,001-100,000	91	17	145	13	9	9	15	10	24	14	1	10	11
100,001-500,000	69	10	141	7	11	15	18	8	61	18	2	25	26
500,001 & Over	28	7	63	1	3	11	7	3	20	8	0	0	0
Total	1,359	277	1,425	8	189	252	24	137	407	21	26	239	6
COMMERCIAL													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	1	1	2	0	0	0	0	0	0	0	0	0
1,001-5,000	124	9	37	7	2	2	3	4	5	4	5	216	37
5,001-10,000	97	17	63	3	1	1	1	5	5	4	0	0	0
10,001-25,000	98	26	159	18	4	7	8	10	16	10	2	21	45
25,001-50,000	120	29	175	16	3	6	6	7	8	3	1	25	16
50,001-100,000	91	16	119	11	2	2	3	7	14	8	1	6	6
100,001-500,000	69	22	380	19	5	8	9	8	23	7	2	7	7
500,001 & Over	28	10	369	10	2	2	1	3	11	4	0	0	0
Total	641	130	1,303	12	19	28	4	44	82	6	11	275	20
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	9	9	2	0	0	0	0	0	0	0	0	0
1,001-5,000	458	33	136	7	7	7	2	14	18	4	18	797	37
5,001-10,000	228	40	148	3	2	2	0	11	11	3	0	0	0
10,001-25,000	204	54	331	18	8	14	7	20	33	10	4	43	45
25,001-50,000	120	29	175	16	3	6	6	7	8	3	1	25	16
50,001-100,000	91	16	119	11	2	2	3	7	14	8	1	6	6
100,001-500,000	69	22	380	19	5	8	9	8	23	7	2	7	7
500,001 & Over	28	10	369	10	2	2	1	3	11	4	0	0	0
Total	1,359	213	1,667	10	29	41	4	70	118	6	26	878	23

TABLE E-16D—SUMMARY OF LAND USE CHARACTERISTICS AT OVERFLOW POINTS BY SOURCE OF OVERFLOW AND POPULATION GROUP

		Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
Pop. Group	No. of Jurisdictions	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow
OTHER													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	2	26	32
1,001-5,000	124	3	11	2	2	2	3	0	0	0	0	0	0
5,001-10,000	97	3	6	0	4	13	13	2	12	10	2	5	7
10,001-25,000	98	1	1	0	1	1	1	0	0	0	0	0	0
25,001-50,000	120	6	26	2	3	3	3	3	16	7	2	44	29
50,001-100,000	91	0	0	0	1	1	1	1	1	0	0	0	0
100,001-500,000	69	3	44	2	2	2	2	2	9	2	0	0	0
500,001 & Over	28	3	108	3	2	3	2	2	2	0	1	3	1
Total	641	19	196	1	15	25	4	10	40	3	7	78	5
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	18	240	32
1,001-5,000	458	11	40	2	7	7	2	0	0	0	0	0	0
5,001-10,000	228	7	14	0	9	30	13	4	28	10	4	11	7
10,001-25,000	204	2	2	0	2	2	1	0	0	0	0	0	0
25,001-50,000	120	6	26	2	3	3	3	3	16	7	2	44	29
50,001-100,000	91	0	0	0	1	1	1	1	1	0	0	0	0
100,001-500,000	69	3	44	2	2	2	2	2	9	2	0	0	0
500,001 & Over	28	3	108	3	2	3	2	2	2	0	1	3	1
Total	1,359	32	234	1	26	48	4	12	56	2	25	298	8
TOTAL													
U. S. TOTALS—SURVEYED													
0-500	2	1	3		0	0		0	0		1	1	
501-1,000	12	6	48		2	1		0	0		2	51	
1,001-5,000	124	93	481		58	64		42	105		10	570	
5,001-10,000	97	75	1,876		56	93		43	118		7	64	
10,001-25,000	98	78	846		75	85		53	155		6	46	
25,001-50,000	120	79	1,035		65	93		56	212		11	151	
50,001-100,000	91	66	1,081		46	57		45	166		4	89	
100,001-500,000	69	60	1,914		43	81		42	328		9	94	
500,001 & Over	28	24	3,417		19	141		16	235		4	225	
Total	641	482	10,701		364	615		297	1,319		54	1,321	
U. S. TOTALS—PROJECTED													
0-500	50	25	75		0	0		0	0		25	25	
501-1,000	111	55	444		18	9		0	0		18	749	
1,001-5,000	458	343	1,776		214	236		155	387		36	2,105	
5,001-10,000	228	176	4,416		131	218		101	277		16	150	
10,001-25,000	204	162	1,762		156	177		110	322		12	95	
25,001-50,000	120	79	1,035		65	93		56	212		11	151	
50,001-100,000	91	66	1,081		46	57		45	166		4	89	
100,001-500,000	69	60	1,914		43	81		42	328		9	94	
500,001 & Over	28	24	3,417		19	141		16	235		4	225	
Total	1,359	990	15,920		692	1,012		525	1,927		135	3,683	

TABLE E-17A—SUMMARY OF PRESENT HIGHEST USE OF RECEIVING WATER IN VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW AND POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Report ing	No. Overflow Points	% of Total By Source of Overflow
POTABLE WATER													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	1	6	7
1,001-5,000	124	6	16	3	2	2	1	3	6	4	2	62	10
5,001-10,000	97	4	26	1	3	4	5	2	10	9	0	0	0
10,001-25,000	98	5	36	4	4	4	4	4	14	8	0	0	0
25,001-50,000	120	8	141	13	6	7	8	3	5	2	1	20	17
50,001-100,000	91	5	252	20	3	3	5	3	19	11	0	0	0
100,001-500,000	69	2	37	1	1	4	4	3	16	4	0	0	0
500,001 & Over	28	1	6	0	1	2	2	0	0	0	0	0	0
Total	641	31	514	5	20	26	4	18	70	4	4	88	5
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	9	55	7
1,001-5,000	458	22	59	3	7	7	1	11	22	4	7	229	10
5,001-10,000	228	9	61	1	7	9	5	4	23	8	0	0	0
10,001-25,000	204	10	75	4	8	8	4	8	29	8	0	0	0
25,001-50,000	120	8	141	13	6	7	8	3	5	2	1	20	17
50,001-100,000	91	5	252	20	3	3	5	3	19	11	0	0	0
100,001-500,000	69	2	37	1	1	4	4	3	16	4	0	0	0
500,001 & Over	28	1	6	0	1	2	2	0	0	0	0	0	0
Total	1,359	57	631	4	33	40	3	32	114	5	17	304	7
BODY CONTACT RECREATION													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	1	18	22
1,001-5,000	124	5	21	4	7	7	5	5	7	4	0	0	0
5,001-10,000	97	7	930	67	3	4	5	3	11	10	0	0	0
10,001-25,000	98	8	46	5	8	9	9	7	23	14	0	0	0
25,001-50,000	120	9	59	5	5	6	7	5	18	8	1	41	36
50,001-100,000	91	5	30	2	3	3	5	2	10	6	0	0	0
100,001-500,000	69	6	41	1	2	7	8	4	9	2	0	0	0
500,001 & Over	28	6	78	2	4	4	4	3	25	7	1	170	27
Total	641	46	1,205	11	32	40	6	29	103	6	3	229	13
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	9	166	22
1,001-5,000	458	18	77	4	25	25	5	18	25	4	0	0	0
5,001-10,000	228	16	2,189	67	7	9	5	7	25	9	0	0	0
10,001-25,000	204	16	95	5	16	18	9	14	47	14	0	0	0
25,001-50,000	120	9	59	5	5	6	7	5	18	8	1	41	36
50,001-100,000	91	5	30	2	3	3	5	2	10	6	0	0	0
100,001-500,000	69	6	41	1	2	7	8	4	9	2	0	0	0
500,001 & Over	28	6	78	2	4	4	4	3	25	7	1	170	27
Total	1,359	76	2,569	17	62	72	6	53	159	7	11	377	9

TABLE E-17B—SUMMARY OF PRESENT HIGHEST USE OF RECEIVING WATER IN VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW AND POPULATION GROUP

		Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
Pop. Group	No. of Jurisdictions	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow
LIMITED BODY CONTACT RECREATION													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	1	3	10	1	1	100	0	0	0	0	0	0
1,001-5,000	124	8	42	3	5	5	4	5	10	7	3	79	13
5,001-10,000	97	13	85	6	12	13	18	10	21	19	2	18	22
10,001-25,000	98	17	191	22	15	16	17	14	30	19	1	11	32
25,001-50,000	120	16	233	22	14	15	17	13	48	22	2	2	1
50,001-100,000	91	22	388	30	11	12	21	12	34	21	1	1	1
100,001-500,000	69	22	511	23	11	13	15	8	49	13	1	5	5
500,001 & Over	28	9	190	6	4	17	20	7	95	28	1	3	0
Total	641	108	1,643	16	73	92	15	69	287	19	11	119	7
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	9	27	9	9	9	100	0	0	0	0	0	0
1,001-5,000	458	29	155	8	18	18	3	18	36	6	11	291	13
5,001-10,000	228	30	200	6	28	30	18	23	49	19	4	42	22
10,001-25,000	204	35	397	22	31	33	17	29	62	18	2	22	31
25,001-50,000	120	16	233	22	14	15	17	13	48	22	2	2	1
50,001-100,000	91	22	388	30	11	12	21	12	34	21	1	1	1
100,001-500,000	69	22	511	23	11	13	15	8	49	13	1	5	5
500,001 & Over	28	9	190	6	4	17	20	7	95	28	1	3	0
Total	1,359	172	2,101	14	126	147	13	110	373	17	22	366	9
FISHING													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	3	10	33	0	0	0	0	0	0	1	55	67
1,001-5,000	124	30	127	25	22	22	17	14	39	27	3	4	0
5,001-10,000	97	18	101	7	19	20	28	11	25	22	2	2	2
10,001-25,000	98	24	105	12	24	31	33	15	39	24	3	22	64
25,001-50,000	120	27	289	27	25	30	35	19	51	23	2	3	2
50,001-100,000	91	13	158	12	14	15	26	9	14	8	0	0	0
100,001-500,000	69	16	358	16	12	19	22	11	51	13	2	25	25
500,001 & Over	28	8	447	15	8	30	35	4	26	7	2	301	49
Total	641	139	1,595	15	124	167	28	83	245	16	15	412	24
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	[illegible]	0	0	0
501-1,000	111	27	92	33	0	0	0	0	0	[illegible]	9	508	67
1,001-5,000	458	110	469	25	81	81	17	51	144	[illegible]	11	14	0
5,001-10,000	228	42	237	7	44	47	29	25	56	[illegible]	4	4	2
10,001-25,000	204	50	218	12	50	64	33	31	81	[illegible]	6	45	64
25,001-50,000	120	27	289	27	25	30	35	19	51	23	2	3	2
50,001-100,000	91	13	158	12	14	15	26	9	14	8	0	0	0
100,001-500,000	69	16	358	16	12	19	22	11	51	13	2	25	25
500,001 & Over	28	8	447	15	8	30	35	4	26	7	2	301	49
Total	1,359	293	2,268	15	234	286	25	150	425	19	36	900	22

TABLE E-17C—SUMMARY OF PRESENT HIGHEST USE OF RECEIVING WATER IN VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW AND POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow
SHELLFISH													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	124	1	1	0	0	0	0	0	0	0	1	2	0
5,001-10,000	97	0	0	0	0	0	0	0	0	0	1	1	1
10,001-25,000	98	0	0	0	1	1	1	1	3	1	0	0	0
25,001-50,000	120	3	19	1	1	1	1	2	3	1	0	0	0
50,001-100,000	91	0	0	0	0	0	0	0	0	0	0	0	0
100,001-500,000	69	0	0	0	0	0	0	0	0	0	0	0	0
500,001 & Over	28	1	24	0	1	1	1	1	2	0	0	0	0
Total	641	5	44	0	3	3	0	4	8	0	2	3	0
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	458	3	3	0	0	0	0	0	0	0	3	7	0
5,001-10,000	228	0	0	0	0	0	0	0	0	0	2	2	1
10,001-25,000	204	0	0	0	2	2	1	2	6	1	0	0	0
25,001-50,000	120	3	19	1	1	1	1	2	3	1	0	0	0
50,001-100,000	91	0	0	0	0	0	0	0	0	0	0	0	0
100,001-500,000	69	0	0	0	0	0	0	0	0	0	0	0	0
500,001 & Over	28	1	24	0	1	1	1	1	2	0	0	0	0
Total	1,359	7	46	0	4	4	0	5	11	0	5	9	0
INDUSTRIAL COOLING													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	124	2	12	2	0	0	0	1	1	0	0	0	0
5,001-10,000	97	3	12	0	2	2	2	1	3	2	0	0	0
10,001-25,000	98	3	35	4	2	2	2	1	3	1	0	0	0
25,001-50,000	120	3	22	2	1	1	1	3	4	1	1	23	20
50,001-100,000	91	10	51	4	4	4	7	2	3	1	1	20	21
100,001-500,000	69	15	410	18	7	9	10	8	23	6	0	0	0
500,001 & Over	28	7	758	26	4	6	7	5	22	6	1	23	3
Total	641	43	1,300	12	20	24	4	21	59	3	3	66	3
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	458	7	44	2	0	0	0	3	3	0	0	0	0
5,001-10,000	228	7	28	0	4	4	2	2	7	2	0	0	0
10,001-25,000	204	6	72	4	4	4	2	2	6	1	0	0	0
25,001-50,000	120	3	22	2	1	1	1	3	4	1	1	23	20
50,001-100,000	91	10	51	4	4	4	7	2	3	1	1	20	21
100,001-500,000	69	15	410	18	7	9	10	8	23	6	0	0	0
500,001 & Over	28	7	758	26	4	6	7	5	22	6	1	23	3
Total	1,359	55	1,385	9	24	28	2	25	68	3	3	66	1

TABLE E-17D—SUMMARY OF PRESENT HIGHEST USE OF RECEIVING WATER IN VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Report ing	No. Overflow Points	% of Total By Source of Overflow
INDUSTRIAL PROCESS WATER													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	124	1	10	2	0	0	0	0	0	0	0	0	0
5,001-10,000	97	1	3	0	0	0	0	1	4	3	1	2	2
10,001-25,000	98	7	57	6	2	2	2	1	1	0	0	0	0
25,001-50,000	120	4	27	2	1	1	1	3	5	2	0	0	0
50,001-100,000	91	3	47	3	4	5	8	3	10	6	0	0	0
100,001-500,000	69	9	139	6	7	7	8	3	15	4	0	0	0
500,001 & Over	28	4	90	3	2	2	2	0	0	0	1	4	0
Total	641	29	373	3	16	17	2	11	35	2	2	6	0
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	458	3	36	1	0	0	0	0	0	0	0	0	0
5,001-10,000	228	2	7	0	0	0	0	2	9	3	2	4	2
10,001-25,000	204	14	118	6	4	4	2	2	2	0	0	0	0
25,001-50,000	120	4	27	2	1	1	1	3	5	2	0	0	0
50,001-100,000	91	3	47	3	4	5	8	3	10	6	0	0	0
100,001-500,000	69	9	139	6	7	7	8	3	15	4	0	0	0
500,001 & Over	28	4	90	3	2	2	2	0	0	0	1	4	0
Total	1,359	39	464	3	18	19	1	13	41	1	3	8	0
AGRICULTURE OR IRRIGATION													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	124	5	9	1	4	4	3	3	3	2	0	0	0
5,001-10,000	97	6	39	2	5	6	8	4	9	8	0	0	0
10,001-25,000	98	4	15	1	5	6	6	0	0	0	0	0	0
25,001-50,000	120	5	8	0	4	6	7	3	15	7	1	4	3
50,001-100,000	91	5	12	0	2	2	3	2	6	3	0	0	0
100,001-500,000	69	1	20	0	4	7	8	3	93	24	1	26	26
500,001 & Over	28	2	5	0	1	2	2	0	0	0	1	4	0
Total	641	28	108	1	25	33	5	15	126	8	3	34	2
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	458	18	33	1	14	14	3	11	11	2	0	0	0
5,001-10,000	228	14	91	2	11	14	8	9	21	8	0	0	0
10,001-25,000	204	8	31	1	10	12	6	0	0	0	0	0	0
25,001-50,000	120	5	8	0	4	6	7	3	15	7	1	4	3
50,001-100,000	91	5	12	0	2	2	3	2	6	3	0	0	0
100,001-500,000	69	1	20	0	4	7	8	3	93	24	1	26	26
500,001 & Over	28	2	5	0	1	2	2	0	0	0	1	4	0
Total	1,359	53	200	1	46	57	5	28	146	6	3	34	0

TABLE E-17E—SUMMARY OF PRESENT HIGHEST USE OF RECEIVING WATER IN VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow
OPEN DRAINS													
U. S. TOTALS—SURVEYED													
0-500	2	1	3	100	0	0	0	0	0	0	0	0	0
501-1,000	12	3	16	53	0	0	0	0	0	0	0	0	0
1,001-5,000	124	22	172	34	11	72	58	11	19	13	1	18	3
5,001-10,000	97	11	91	6	10	11	15	9	17	15	2	21	25
10,001-25,000	98	14	120	14	6	12	13	12	36	22	1	1	2
25,001-50,000	120	14	169	16	10	12	14	12	39	18	4	18	15
50,001-100,000	91	14	120	9	5	6	10	14	46	28	4	71	76
100,001-500,000	69	14	329	15	4	9	10	14	82	21	3	35	35
500,001 & Over	28	10	1,066	36	4	19	22	7	117	35	1	15	2
Total	641	103	2,086	20	50	141	23	79	356	23	16	179	10
U. S. TOTALS—PROJECTED													
0-500	50	25	75	100	0	0	0	0	0	0	0	0	0
501-1,000	111	27	148	53	0	0	0	0	0	0	0	0	0
1,001-5,000	458	81	635	34	40	265	58	40	70	13	3	66	3
5,001-10,000	228	25	214	6	23	25	15	21	40	15	4	49	25
10,001-25,000	204	29	250	14	12	25	13	25	75	22	2	2	2
25,001-50,000	120	14	169	16	10	12	14	12	39	18	4	18	15
50,001-100,000	91	14	120	9	5	6	10	14	46	28	4	71	76
100,001-500,000	69	14	329	15	4	9	10	14	82	21	3	35	35
500,001 & Over	28	10	1,066	36	4	19	22	7	117	35	1	15	2
Total	1,359	239	3,006	20	98	361	32	133	469	21	21	256	6
NOT SPECIFIED													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	1	1	100
501-1,000	12	1	1	3	0	0	0	0	0	0	1	2	2
1,001-5,000	124	18	88	17	9	11	8	8	57	40	3	406	71
5,001-10,000	97	15	88	6	9	9	13	6	9	8	2	37	45
10,001-25,000	98	14	240	28	7	9	9	4	8	5	0	0	0
25,001-50,000	120	8	86	8	6	6	7	8	25	11	2	2	1
50,001-100,000	91	12	195	15	6	6	10	7	17	10	1	1	1
100,001-500,000	68	10	338	15	5	8	9	7	37	9	1	8	8
500,001 & Over	28	8	237	8	2	2	2	4	44	13	1	91	14
Total	641	86	1,273	12	44	51	8	44	197	13	12	548	32
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	25	25	100
501-1,000	111	9	9	3	0	0	0	0	0	0	9	18	2
1,001-5,000	458	66	325	17	33	40	8	29	210	40	11	1,499	71
5,001-10,000	228	35	207	6	21	21	12	14	21	8	4	87	45
10,001-25,000	204	29	500	28	14	18	9	8	16	4	0	0	0
25,001-50,000	120	8	86	8	6	6	7	8	25	11	2	2	1
50,001-100,000	91	12	195	15	6	6	10	7	17	10	1	1	1
100,001-500,000	69	10	338	15	5	8	9	7	37	9	1	8	8
500,001 & Over	28	8	237	8	2	2	2	4	44	13	1	91	14
Total	1,359	177	1,897	13	87	101	8	77	370	16	54	1,731	42

TABLE E-17F—SUMMARY OF PRESENT HIGHEST USE OF RECEIVING WATER IN VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow
TOTAL													
U. S. TOTALS—SURVEYED													
0-500	2	1	3		0	0		0	0		1	1	
501-1,000	12	[illegible]	30		1	1		0	0		4	81	
1,001-5,000	124	98	498		60	123		50	142		13	571	
5,001-10,000	97	78	1,375		63	69		47	109		10	81	
10,001-25,000	98	96	845		74	92		59	[illegible]		5	34	
25,001-50,000	120	97	1,053		73	85		71	213		14	113	
50,001-100,000	91	89	1,253		52	56		54	159		7	93	
100,001-500,000	69	95	2,183		53	83		61	375		8	99	
500,001 & Over	28	56	2,901		31	85		31	331		9	611	
Total	641	618	10,141		407	594		373	1,486		71	1,684	
U. S. TOTALS—PROJECTED													
0-500	50	25	75		0	0		0	0		25	25	
501-1,000	111	74	277		9	9		0	0		37	749	
1,001-5,000	458	361	1,839		221	454		184	524		48	2,109	
5,001-10,000	228	183	3,236		148	162		110	256		23	190	
10,001-25,000	204	200	1,760		154	191		122	327		10	70	
25,001-50,000	120	97	1,053		73	85		71	213		14	113	
50,001-100,000	91	89	1,253		52	56		54	159		7	93	
100,001-500,000	69	95	2,183		53	83		61	375		8	99	
500,001 & Over	28	56	2,901		31	85		31	331		9	611	
Total	1,359	1,180	14,577		741	1,125		633	2,185		181	4,059	

TABLE E-18A—SUMMARY OF NATURE OF RECEIVING WATER IN THE VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Report ing	No. Overflow Points	% of Total By Source of Overflow
LAKE													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	1	1	3	0	0	0	0	0	0	0	0	0
1,001-5,000	124	3	26	4	2	2	3	1	1	0	1	13	2
5,001-10,000	97	4	14	0	2	3	4	2	9	7	0	0	0
10,001-25,000	98	3	33	3	2	2	2	2	3	1	1	1	2
25,001-50,000	120	6	838	45	3	3	3	2	2	0	1	2	2
50,001-100,000	91	7	33	3	4	4	6	0	0	0	0	0	0
100,001-500,000	69	8	56	3	5	13	16	7	37	9	1	8	11
500,001 & Over	28	4	30	1	3	6	7	3	25	10	0	0	0
Total	641	36	1,031	9	21	33	6	17	77	5	4	24	1
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	9	9	3	0	0	0	0	0	0	0	0	0
1,001-5,000	458	11	96	4	7	7	3	3	3	0	3	48	2
5,001-10,000	228	9	32	0	4	7	3	4	21	7	0	0	0
10,001-25,000	204	6	68	3	4	4	2	4	6	1	2	2	2
25,001-50,000	120	6	838	45	3	3	3	2	2	0	1	2	2
50,001-100,000	91	7	33	3	4	4	6	0	0	0	0	0	0
100,001-500,000	69	8	56	3	5	13	16	7	37	9	1	8	11
500,001 & Over	28	4	30	1	3	6	7	3	25	10	0	0	0
Total	1,359	60	1,162	7	30	44	4	23	94	4	7	60	1
TIDEWATER													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	124	6	38	6	5	5	8	6	17	12	1	6	1
5,001-10,000	97	8	933	65	6	6	8	4	13	11	0	0	0
10,001-25,000	98	3	116	13	4	8	9	4	23	12	1	11	22
25,001-50,000	120	8	80	4	8	11	11	7	34	16	0	0	0
50,001-100,000	91	8	109	9	4	4	6	6	11	6	1	55	57
100,001-500,000	69	11	411	24	7	11	14	6	28	7	2	17	23
500,001 & Over	28	8	655	21	8	14	16	4	45	19	2	1,299	94
Total	641	52	2,342	22	42	59	11	37	171	12	7	1,388	58
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	0	0	0	0	0	0	0	0	0	0	0	0
1,001-5,000	458	22	140	6	18	18	8	22	62	12	3	22	1
5,001-10,000	228	18	2,196	65	14	14	7	9	30	10	0	0	0
10,001-25,000	204	6	241	13	8	16	9	8	47	11	2	22	22
25,001-50,000	120	8	80	4	8	11	11	7	34	16	0	0	0
50,001-100,000	91	8	109	9	4	4	6	6	11	6	1	55	57
100,001-500,000	69	11	411	24	7	11	14	6	28	7	2	17	23
500,001 & Over	28	8	655	21	8	14	16	4	45	19	2	1,299	94
Total	1,359	81	3,832	25	67	88	9	62	257	11	10	1,415	29

TABLE E-18B—SUMMARY OF NATURE OF RECEIVING WATER IN THE VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow
NORMALLY DRY WATERCOURSE													
U. S. TOTALS— SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	1	6	23	0	0	0	0	0	0	0	0	0
1,001-5,000	124	5	27	4	1	1	1	7	8	5	0	0	0
5,001-10,000	97	8	63	4	3	9	12	3	6	5	0	0	0
10,001-25,000	98	2	3	0	1	1	1	3	8	4	0	0	0
25,001-50,000	120	1	1	0	0	0	0	4	20	9	1	4	4
50,001-100,000	91	0	0	0	0	0	0	2	6	3	0	0	0
100,001-500,000	69	2	25	1	0	0	0	6	16	4	0	0	0
500,001 & Over	28	1	5	0	2	17	20	1	22	9	0	0	0
Total	641	20	130	1	7	28	5	26	86	6	1	4	0
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	9	55	22	0	0	0	0	0	0	0	0	0
1,001-5,000	458	18	99	4	3	3	1	25	29	5	0	0	0
5,001-10,000	228	18	148	4	7	21	11	7	14	5	0	0	0
10,001-25,000	204	4	6	0	2	2	1	6	16	4	0	0	0
25,001-50,000	120	1	1	0	0	0	0	4	20	9	1	4	4
50,001-100,000	91	0	0	0	0	0	0	2	6	3	0	0	0
100,001-500,000	69	2	25	1	0	0	0	6	16	4	0	0	0
500,001 & Over	28	1	5	0	2	17	20	1	22	9	0	0	0
Total	1,359	53	339	2	14	43	4	51	123	5	1	4	0
STREAM WITH DILUTION FACTOR LESS THAN 5													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	1	1	100
501-1,000	12	2	7	26	0	0	0	0	0	0	0	0	0
1,001-5,000	124	9	52	9	4	5	8	4	5	3	0	0	0
5,001-10,000	97	4	17	1	6	8	10	3	4	3	0	0	0
10,001-25,000	98	7	46	5	7	9	11	5	6	3	0	0	0
25,001-50,000	120	9	58	3	2	3	3	3	7	3	1	1	1
50,001-100,000	91	10	114	10	9	13	22	14	49	29	0	0	0
100,001-500,000	69	7	88	5	8	9	11	8	47	12	1	2	2
500,001 & Over	28	5	548	18	3	20	24	3	13	5	0	0	0
Total	641	53	930	8	39	67	12	40	131	9	3	4	0
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	25	25	100
501-1,000	111	18	64	26	0	0	0	0	0	0	0	0	0
1,001-5,000	458	33	192	9	14	18	8	14	18	3	0	0	0
5,001-10,000	228	9	40	1	14	18	10	7	9	3	0	0	0
10,001-25,000	204	14	95	5	14	18	10	10	12	3	0	0	0
25,001-50,000	120	9	58	3	2	3	3	3	7	3	1	1	1
50,001-100,000	91	10	114	10	9	13	22	14	49	29	0	0	0
100,001-500,000	69	7	88	5	8	9	11	8	47	12	1	2	2
500,001 & Over	28	5	548	18	3	20	24	3	13	5	0	0	0
Total	1,359	105	1,199	7	64	99	11	59	155	7	27	28	0

TABLE E-18C—SUMMARY OF NATURE OF RECEIVING WATER IN THE VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW BY POPULATION GROUP

		Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
Pop. Group	No. of Jurisdictions	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Report ing	No. Overflow Points	% of Total By Source of Overflow
STREAM WITH DILUTI_N FACTOR 5 TO 10													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	1	3	11	0	0	0	0	0	0	0	0	0
1,001-5,000	124	11	36	6	7	7	11	3	4	2	0	0	0
5,001-10,000	97	4	13	0	1	1	1	2	9	7	1	2	3
10,001-25,000	98	9	88	10	6	7	8	8	10	5	1	11	22
25,001-50,000	120	7	46	2	4	5	5	4	12	5	0	0	0
50,001-100,000	91	6	87	7	4	4	6	3	6	3	0	0	0
100,001-500,000	69	4	25	1	1	3	3	10	101	27	1	26	36
500,001 & Over	28	5	606	20	3	7	8	4	82	35	2	68	4
Total	641	47	904	8	26	34	6	34	224	15	5	107	4
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	9	27	11	0	0	0	0	0	0	0	0	0
1,001-5,000	458	40	132	6	25	25	11	11	14	2	0	0	0
5,001-10,000	228	9	30	0	2	2	1	4	21	7	2	4	2
10,001-25,000	204	18	183	10	12	14	8	16	20	5	2	22	22
25,001-50,000	120	7	46	2	4	5	5	4	12	5	0	0	0
50,001-100,000	91	6	87	7	4	4	6	3	6	3	0	0	0
100,001-500,000	69	4	25	1	1	3	3	10	101	27	1	26	36
500,001 & Over	28	5	606	20	3	7	8	4	82	35	2	68	4
Total	1,359	98	1,136	7	51	60	6	52	256	11	7	120	2
STREAM WITH DILUTION FACTOR 10 TO 100													
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	2	4	15	1	1	100	0	0	0	0	0	0
1,001-5,000	124	18	173	31	10	10	16	10	23	16	2	5	0
5,001-10,000	97	22	147	10	17	18	24	15	28	24	6	55	90
10,001-25,000	98	12	172	19	9	10	12	9	35	18	5	7	14
25,001-50,000	120	22	226	12	11	22	22	16	44	21	2	8	8
50,001-100,000	91	11	167	15	4	5	8	5	12	7	1	20	21
100,001-500,000	69	11	233	13	2	2	2	8	37	9	0	0	0
500,001 & Over	28	4	428	14	2	3	3	3	16	6	0	0	0
Total	641	102	1,550	14	56	71	13	66	195	13	16	95	3
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	18	37	15	9	9	100	0	0	0	0	0	0
1,001-5,000	458	66	638	31	36	36	16	36	84	16	7	18	0
5,001-10,000	228	51	346	10	40	42	23	35	65	23	14	129	90
10,001-25,000	204	25	358	19	18	20	11	18	72	18	10	14	14
25,001-50,000	120	22	226	12	11	22	22	16	44	21	2	8	8
50,001-100,000	91	11	167	15	4	5	8	5	12	7	1	20	21
100,001-500,000	69	11	233	13	2	2	2	8	37	9	0	0	0
500,001 & Over	28	4	428	14	2	3	3	3	16	6	0	0	0
Total	1,359	208	2,433	16	122	139	15	121	330	15	34	189	3

TABLE E-18D—SUMMARY OF NATURE OF RECEIVING WATER IN THE VICINITY OF OVERFLOW POINTS BY SOURCE OF OVERFLOW BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer			Treatment Plant Bypass			Pumping Station Bypass			Not Otherwise Identified		
		Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow	Jurisdictions Reporting	No. Overflow Points	% of Total By Source of Overflow
STREAM WITH DILUTION FACTOR GREATER THAN 100													
U. S. TOTALS—SURVEYED													
0-500	2	1	3	100	0	0	0	0	0	0	0	0	0
501-1,000	12	1	5	19	0	0	0	0	0	0	3	81	100
1,001-5,000	124	40	193	35	29	31	50	18	79	57	9	552	95
5,001-10,000	97	37	231	16	27	30	40	18	47	40	2	4	6
10,001-25,000	98	48	416	47	41	44	54	32	106	55	5	18	37
25,001-50,000	120	42	583	31	39	54	55	25	83	41	9	74	83
50,001-100,000	91	30	587	53	25	28	48	22	81	49	3	20	21
100,001-500,000	69	25	837	49	23	39	50	18	108	28	2	18	25
500,001 & Over	28	10	709	23	8	16	19	5	27	11	1	4	0
Total	641	234	3,564	34	192	242	45	138	531	37	34	771	32
U. S. TOTALS—PROJECTED													
0-500	50	25	75	100	0	0	0	0	0	0	0	0	0
501-1,000	111	9	46	19	0	0	0	0	0	0	27	749	100
1,001-5,000	458	147	712	35	107	114	50	66	291	57	33	2,038	95
5,001-10,000	228	87	543	16	63	70	39	42	110	40	4	9	6
10,001-25,000	204	100	866	47	85	91	54	66	220	55	10	37	37
25,001-50,000	120	42	583	31	39	54	55	25	83	41	9	74	83
50,001-100,000	91	30	587	53	25	28	48	22	81	49	3	20	21
100,001-500,000	69	25	837	49	23	39	50	18	108	28	2	18	25
500,001 & Over	28	10	709	23	8	16	19	5	27	11	1	4	0
Total	1,359	475	4,958	32	350	412	46	244	920	42	89	2,949	61
TOTAL POINTS													
U. S. TOTALS—SURVEYED													
0-500	2	1	3		0	0		0	0		0	1	
501-1,000	12	7	26		1	1		0	0		3	81	
1,001-5,000	124	90	545		57	61		43	137		8	576	
5,001-10,000	97	72	1,418		54	75		38	116		8	61	
10,001-25,000	98	73	874		70	81		50	191		6	48	
25,001-50,000	120	75	1,832		64	98		52	202		13	89	
50,001-100,000	91	64	1,097		50	58		46	165		5	95	
100,001-500,000	69	53	1,675		42	77		42	374		8	71	
500,001 & Over	28	24	2,981		21	83		17	230		5	1,371	
Total	641	459	11,451		359	534		288	1,415		56	2,393	
U. S. TOTALS—PROJECTED													
0-500	50	25	75		0	0		0	0		0	25	
501-1,000	111	64	240		9	9		0	0		27	749	
1,001-5,000	458	332	2,012		210	225		158	506		29	2,127	
5,001-10,000	228	169	3,338		127	176		89	273		18	143	
10,001-25,000	204	152	1,820		145	168		104	397		12	100	
25,001-50,000	120	75	1,832		64	98		52	202		13	89	
50,001-100,000	91	64	1,097		50	58		46	165		5	95	
100,001-500,000	69	53	1,675		42	77		42	374		8	71	
500,001 & Over	28	24	2,981		21	83		17	230		5	1,371	
Total	1,359	958	15,070		666	894		508	2,147		117	4,770	

TABLE E19—SUMMARY OF SEWERED POPULATION WITH SEWAGE TREATMENT PLANTS, TOTAL SEWAGE TREATMENT PLANT CAPACITY AND CORRELATION AND DEGREE OF TREATMENT PROVIDED BY WATER POLLUTION CONTROL PLANT FACILITIES AND POPULATION GROUP

Pop. Group	No. of Jurisdictions	Sewered Population of Jurisdictions With Treatment Plants (1)	Treatment Plant Capacities				Degree of Treatment Provided—Jurisdictions With							
			Million Gallons Per Day (MGD)	MGD /1000 Sewered Pop.	MGD /1000 Total Pop.	MGD /1000 Acres With Sewer Service	No Treatment	% of Total	Primary Treatment	% of Total	Secondary Treatment	% of Total	Tertiary Treatment	% of Total
U. S. TOTALS—SURVEYED														
0-500	2	0	0	0.0	0.0	0.0	2	100	0	0	0	0	0	0
501-1,000	12	600	1	1.7	1.7	0.1	10	83	1	8	1	8	0	0
1,001-5,000	124	225,519	161	0.7	0.7	0.5	47	37	36	29	40	32	1	0
5,001-10,000	97	515,598	158	0.3	0.2	0.3	23	23	39	40	32	32	3	3
10,001-25,000	98	1,250,926	406	0.3	0.2	0.3	19	19	48	48	30	30	1	1
25,001-50,000	120	2,868,846	807	0.3	0.2	0.3	37	30	49	40	34	28	0	0
50,001-100,000	91	3,872,024	1,097	0.3	0.2	0.3	36	39	31	34	23	25	1	1
100,001-500,000	69	9,914,896	2,825	0.3	0.2	0.4	18	25	25	35	26	36	2	2
500,001 & Over	28	31,961,120	9,372	0.3	0.2	0.5	5	18	10	37	12	44	0	0
Total	641	50,609,529	14,827	0.3	0.2	0.4	197	30	239	37	198	30	8	1
U. S. TOTALS—PROJECTED														
0-500	50	0	0	0.0	0.0	0.0	50	100	0	0	0	0	0	0
501-1,000	111	5,550	9	1.6	1.6	0.1	92	83	9	8	9	8	0	0
1,001-5,000	458	832,965	594	0.7	0.7	0.5	173	38	132	29	147	32	3	0
5,001-10,000	228	1,213,803	371	0.3	0.2	0.3	54	23	91	40	75	33	7	3
10,001-25,000	204	2,606,095	845	0.3	0.2	0.3	39	19	100	49	62	30	2	0
25,001-50,000	120	2,868,846	807	0.3	0.2	0.3	37	30	49	40	34	28	0	0
50,001-100,000	91	3,872,024	1,097	0.3	0.2	0.3	36	39	31	34	23	25	1	1
100,001-500,000	69	9,914,896	2,825	0.3	0.2	0.4	18	25	25	35	26	36	2	2
500,001 & Over	28	31,961,120	9,372	0.3	0.2	0.5	5	18	10	37	12	44	0	0
Total	1,359	53,275,299	15,920	0.3	0.2	0.4	504	37	447	33	388	28	15	1

NOTE: (1) This population is the total sewered population of communities reporting a sewage treatment plant. It includes the total population served by the Sanitary District or Authority including that of constituent jurisdictions not surveyed.

TABLE E-20—SUMMARY OF REPORTED B.O.D. REMOVALS FOR DRY AND WET WEATHER, PLANNED SEWAGE TREATMENT PLANT CONSTRUCTION, AVAILABILITY OF FUNDS FOR CONSTRUCTION AND, IF FEDERAL FUNDS WILL BE REQUESTED, THE GOVERNMENTAL AGENCY FROM WHICH FUNDS WILL BE REQUESTED BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	No. of Jurisdictions Reporting	Flow Average										Ratio Dry Flow /Wet Wthr. Flow	Planned Additions		Funds Available		Federal Funds to Be Requested If Yes, from Which Federal Agency						
			Dry Weather				Wet Weather																	
			Flow Average M.G.D.	P.P.M. B.O.D.	No. of Jurisdictions Reporting	% B.O.D. Reduction	No. Reporting	Flow Average	P.P.M. B.O.D.	No. of Jurisdictions Reporting	% B.O.D. Reduction		Yes	No.	Yes	No.	Yes	No	FWP[1]	HUD[2]	EDA[3]	FHA[4]	OTH[5]
U. S. TOTALS—SURVEYED																								
0-500	2	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0	0	0	0	1
501-1,000	12	1	1	0	0	0	1	1	0	0	0	1.00	7	1	1	5	6	1	2	3	0	2	2
1,001-5,000	124	65	68	256	34	65	53	80	182	19	62	0.85	41	51	9	34	32	7	25	10	8	9	27
5,001-10,000	97	72	93	297	46	63	65	166	137	27	59	0.56	31	47	7	26	21	8	22	7	2	0	22
10,001-25,000	98	77	187	197	62	62	74	454	176	45	62	0.41	41	40	12	32	27	13	28	12	1	1	31
25,001-50,000	120	82	430	237	66	61	77	751	156	41	56	0.57	52	34	12	39	39	9	31	16	1	3	35
50,001-100,000	91	55	612	214	50	62	50	1,087	132	29	02	0.56	42	15	15	25	29	10	23	9	1	0	24
100,001-500,000	69	52	1,675	221	47	60	45	2,708	141	26	62	0.62	44	9	13	31	39	4	34	15	2	0	33
500,001 & Over	28	22	5,737	236	21	54	17	6,636	164	14	53	0.86	17	4	9	8	11	6	12	5	2	0	17
Total	641	426	8,803	234	326	61	382	11,883	155	201	60	0.74	275	201	78	200	204	58	177	77	17	15	192
U. S. TOTALS—PROJECTED																								
0-500	50	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0	0	0	0	25
501-1,000	111	9	9	0	0	0	9	9	0	0	0	1.00	64	9	9	46	55	9	18	27	0	18	18
1,001-5,000	458	240	251	258	125	65	195	295	183	70	62	0.85	151	188	33	125	118	25	92	36	29	33	99
5,001-10,000	228	169	218	299	108	63	153	390	139	63	59	0.56	72	110	16	61	49	18	51	16	4	0	51
10,001-25,000	204	160	389	197	129	62	154	945	177	93	63	0.41	85	83	25	66	56	27	58	25	2	2	64
25,001-50,000	120	82	430	237	66	61	77	751	156	41	56	0.57	52	34	12	39	39	9	31	16	1	3	35
50,001-100,000	91	55	612	214	50	62	50	1,087	132	29	62	0.56	42	15	15	25	29	10	23	9	1	0	24
100,001-500,000	69	52	1,675	221	47	60	45	2,708	141	26	62	0.62	44	9	13	31	39	4	34	15	2	0	33
500,001 & Over	28	22	5,737	236	21	54	17	6,636	164	14	53	0.86	17	4	9	8	11	6	12	5	2	0	17
Total	1,359	789	9,321	241	546	62	700	12,821	161	336	61	0.73	527	452	132	401	396	108	319	149	41	56	366

KEY: [1] Federal Water Pollution Control Administration.
[2] Dept. of Housing and Urban Development.
[3] Economic Development Administration.
[4] Farm and Home Administration.
[5] Other.

TABLE E-21—SUMMARY OF REPORTS OF ANNUAL HOURS SEWAGE TREATMENT PLANT IS BYPASSED BY REASON; COMBINED SEWAGE PUMPING STATION BYPASSES BY HOURS AND QUANTITY BYPASSED; AND NUMBER OF COMMUNITIES WITH OFF-SEWER SYSTEM SANITARY DISCHARGES TO RECEIVING BODIES, WITH THE NUMBER OF SUCH LOCATIONS AND COMMUNITY PLANS TO ELIMINATE THE PROBLEM, BY POPULATION GROUP

		Sewage Treatment Plant Bypass								Combined Sewer Pumping Station Bypass						Current Correction Plans	
		Maintenance		Breakdowns		Wet Weather		Other									
Pop. Group	No. of Jurisdictions	No. Reporting	Hours	No. Reporting	Hours	No. Reporting	Hours	No. Reporting	Hours	No. Reporting	Hours	No. Reporting	Quantity M.G.D.	Quantity M.G.D. /Hour	No. of Sanitary Sewage Discharges	Yes	No
U. S. TOTALS—SURVEYED																	
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0	0.00	35	1	1
501-1,000	12	0	0	1	25	0	0	0	0	0	0	0	0	0.00	110	5	0
1,001-5,000	124	15	629	20	591	30	18,323	4	1,844	23	8,450	6	268	0.03	613	32	19
5,001-10,000	97	18	580	29	1,067	34	6,218	4	9,576	26	14,525	11	1,490	0.10	1,524	22	19
10,001-25,000	98	22	1,127	25	2,659	38	9,046	6	1,026	32	7,350	8	1,132	0.15	969	22	10
25,001-50,000	120	13	375	28	2,062	36	12,615	9	3,610	30	11,070	9	1,418	0.13	1,536	30	14
50,001-100,000	91	8	479	14	1,044	28	10,358	6	1,096	20	4,424	7	902	0.20	1,322	20	7
100,001-500,000	69	8	1,122	17	944	18	8,124	7	3,100	16	5,141	6	6,603	1.28	1,095	17	9
500,001 & Over	28	5	3,549	5	1,026	13	4,076	2	520	8	1,089	5	5,917	5.43	555	6	3
Total	641	89	7,861	139	9,418	197	68,760	38	20,772	155	52,049	52	17,730	0.34	7,759	155	82
U. S. TOTALS—PROJECTED																	
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0	0.00	875	25	25
501-1,000	111	0	0	9	231	0	0	0	0	0	0	0	0	0.00	1,017	46	0
1,001-5,000	458	55	2,323	73	2,182	110	67,676	14	6,810	84	31,210	22	989	0.03	2,264	118	70
5,001-10,000	228	42	1,365	68	2,511	80	14,638	9	22,543	61	34,194	25	3,507	0.10	3,587	51	44
10,001-25,000	204	45	2,347	52	5,539	79	18,845	12	2,137	66	15,312	16	2,358	0.15	2,018	45	20
25,001-50,000	120	13	375	28	2,062	36	12,615	9	3,610	30	11,070	9	1,418	0.13	1,536	30	14
50,001-100,000	91	8	479	14	1,044	28	10,358	6	1,096	20	4,424	7	902	0.20	1,322	20	7
100,001-500,000	69	8	1,122	17	944	18	8,124	7	3,100	16	5,141	6	6,603	1.28	1,095	17	9
500,001 & Over	28	5	3,549	5	1,026	13	4,076	2	520	8	1,089	5	5,917	5.43	555	6	3
Total	1,359	176	11,560	266	15,539	364	136,332	59	39,816	285	102,440	90	21,694	0.21	14,269	358	192

TABLE E-22—SUMMARY OF REPORTED SEWER SEPARATION PROJECTS BY MILES OF SEWER, COST, AND AREA SERVED FOR 1957-1962 AND 1963-1967 BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	1957-1962						1963-1967					
		No. Reporting	Miles of Sewer Construction	Area Served (Acres)	Cost	No. of Projects	Area Served /Mile of Sewer	No. Reporting	Miles of Sewer Construction	Area Served (Acres)	Cost	No. of Projects	Area Served /Mile of Sewer
U. S. TOTALS—SURVEYED													
0-500	2	0	0	0	$ 0	0	0.00	0	0	0	$ 0	0	0.00
501-1,000	12	0	0	0	0	0	0.00	0	0	0	0	0	0.00
1,001-5,000	124	9	38	2,420	1,234,000	17	68.38	13	126	2,325	2,023,750	36	18.45
5,001-10,000	97	12	71	3,640	1,998,336	44	51.27	17	89	4,497	3,706,740	76	50.53
10,001-25,000	98	11	71	2,438	4,466,984	68	34.34	17	109	3,719	5,147,600	81	34.12
25,001-50,000	120	14	127	6,826	5,464,483	232	53.75	24	236	19,422	20,484,829	288	82.30
50,001-100,000	91	7	209	7,050	12,635,000	91	33.73	15	418	11,582	36,048,000	127	27.71
100,001-500,000	69	11	173	13,855	28,229,525	280	80.09	17	236	68,815	47,561,531	268	291.59
500,001 & Over	28	1	81	1,237	4,693,332	2	15.27	5	290	6,561	18,895,962	12	22.62
Total	641	65	770	37,466	$58,721,660	734	48.76	108	1,504	116,921	$133,868,412	888	77.74
U. S. TOTALS—PROJECTED													
0-500	50	0	0	0	$ 0	0	0.00	0	0	0	$ 0	0	0.00
501-1,000	111	0	0	0	0	0	0.00	0	0	0	0	0	0.00
1,001-5,000	458	33	140	8,900	4,557,838	62	63.57	48	465	8,587	7,474,818	132	18.47
5,001-10,000	228	28	167	8,569	4,704,416	103	51.31	40	209	10,586	8,726,283	178	50.65
10,001-25,000	204	22	147	5,079	9,306,216	141	34.55	35	227	7,747	10,724,166	168	34.13
25,001-50,000	120	14	127	6,826	5,464,483	232	53.75	24	236	19,422	20,484,829	288	82.30
50,001-100,000	91	7	209	7,050	12,635,000	91	33.73	15	418	11,582	36,048,000	127	27.71
100,001-500,000	69	11	173	13,855	28,229,525	280	80.09	17	236	68,815	47,561,531	268	291.59
500,001 & Over	28	1	81	1,237	4,693,332	2	15.27	5	290	6,561	18,895,962	12	22.62
Total	1,359	116	1,044	51,516	$69,590,810	911	49.34	184	2,081	133,300	$149,915,589	1,173	64.06

TABLE E-23—SUMMARY OF FREQUENCY AND DURATION OF COMBINED SEWER OVERFLOWS; STORM SEWER DISCHARGE; AVERAGE NUMBER OF RAINSTORMS EXCEEDING 0.04"; AND TABULATION OF REPLIES AS TO OBJECTIONABLE EFFECTS OF STORM WATER OVERFLOWS BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Combined Sewer Overflow Frequency and Duration			Annual Average Hours of Combined Sewer Overflow	Storm Sewer Discharge Frequency and Duration				Ave. No. of Rainfall Events Exceeding 0.04"	Types of Objectionable Results from Combined Sewer Overflows					
		No. Reporting	Frequency	Duration (Hours)		No. Reporting	Frequency	Duration (Hours)	Annual Average Hours of Separate Storm Sewer Discharge		(1)	(2)	(3)	(4)	(5)	(6)
U. S. TOTALS—SURVEYED																
0-500	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	12	1	20	3	60	0	0	0	0	94	5	0	3	1	6	0
1,001-5,000	124	29	26	5	100	14	94	13	1,128	95	32	3	18	3	41	6
5,001-10,000	97	40	25	5	125	23	84	8	588	81	22	4	21	7	33	11
10,001-25,000	98	43	26	5	130	24	100	6	495	87	20	4	15	4	43	8
25,001-50,000	120	45	25	4	72	32	84	6	504	69	34	8	17	10	48	11
50,001-100,000	91	38	27	3	78	24	65	5	256	78	27	3	20	8	38	10
100,001-500,000	69	33	33	5	132	18	84	8	588	78	32	4	25	9	38	10
500,001 & Over	28	17	44	6	264	7	66	6	396	84	13	1	12	3	13	5
Total	641	246	28	5	112	142	84	7	581	81	185	27	131	45	260	61
U. S. TOTALS—PROJECTED																
0-500	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
501-1,000	111	9	21	3	60	0	0	0	0	97	46	0	27	9	55	0
1,001-5,000	458	107	26	5	100	51	95	13	1,140	95	118	11	66	11	151	22
5,001-10,000	228	94	25	5	125	54	84	8	588	81	51	9	49	16	77	25
10,001-25,000	204	89	27	5	130	50	100	6	495	88	41	8	31	8	89	16
25,001-50,000	120	45	25	4	72	32	84	6	504	69	34	8	17	10	48	11
50,001-100,000	91	38	27	3	78	24	65	5	256	78	27	3	20	8	38	10
100,001-500,000	69	33	33	5	132	18	84	8	588	78	32	4	25	9	38	10
500,001 & Over	28	17	44	6	264	7	66	6	396	84	13	1	12	3	13	5
Total	1,359	432	27	5	108	236	87	8	696	84	362	44	247	74	509	99

KEY: [1] Pollution of recreation areas.
[2] Offensive to users of abutting property.
[3] Renders land unusable.
[4] Floating debris objectionable.
[5] Property damage.
[6] Health hazard.

TABLE E-24A—SUMMARY OF REMEDIAL ACTION PROPOSED IN ENGINEERING REPORTS BY TYPE OF PROJECT; NUMBER, COST, COST-PER-ACRE, AND PERCENT OF CITY SERVED BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Type of Remedial Action: Separation					Type of Remedial Action: Screening				
		No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area	No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area
U. S. TOTALS—SURVEYED											
0-500	2	0	0	$ 0	$ 0	0.00	0	0	$ 0	$ 0	0.00
501-1,000	12	3	1,310	294,000	224	0.35	1	0	0	0	0.00
1,001-5,000	124	40	28,694	13,723,959	478	0.47	3	100	0	0	0.00
5,001-10,000	97	39	20,559	31,411,942	1,528	0.28	1	0	0	0	0.00
10,001-25,000	98	41	79,621	106,927,420	1,343	0.50	1	0	0	0	0.00
25,001-50,000	120	44	61,145	129,240,000	2,114	0.22	5	8,447	10,750,000	1,273	0.03
50,001-100,000	91	33	85,441	1,246,736,100	14,592	0.20	6	8,532	160,000	19	0.02
100,001-500,000	69	26	190,221	1,150,079,000	6,046	0.34	1	1,800	4,320,000	2,400	0.00
500,001 & Over	28	6	93,420	142,748,000	1,528	0.13	0	0	0	0	0.00
Total	641	232	560,411	$2,821,160,321	$ 5,034	0.24	18	18,879	$15,230,000	$ 807	0.01
U. S. TOTALS—PROJECTED											
0-500	50	0	0	$ 0	$ 0	0.00	0	0	$ 0	$ 0	0.00
501-1,000	111	27	12,117	2,719,500	224	0.35	9	0	0	0	0.00
1,001-5,000	458	147	105,982	50,690,106	478	0.47	11	369	0	0	0.00
5,001-10,000	228	91	48,399	73,948,711	1,528	0.28	2	0	0	0	0.00
10,001-25,000	204	85	165,877	222,765,456	1,343	0.50	2	0	0	0	0.00
25,001-50,000	120	44	61,145	129,240,000	2,114	0.22	5	8,447	10,750,000	1,273	0.03
50,001-100,000	91	33	85,441	1,246,736,096	14,592	0.20	6	8,532	160,000	19	0.02
100,001-500,000	69	26	190,221	1,150,076,992	6,046	0.34	1	1,800	4,320,000	2,400	0.00
500,001 & Over	28	6	93,420	142,748,032	1,528	0.13	0	0	0	0	0.00
Total	1,359	459	762,602	$3,018,926,893	$ 3,959	0.28	36	19,148	$15,230,000	$ 795	0.01

TABLE E-24B—SUMMARY OF REMEDIAL ACTION PROPOSED BY ENGINEERING REPORTS BY TYPE OF PROJECT; NUMBER, COST, COST-PER-ACRE, AND PERCENT OF CITY SERVED BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Type of Remedial Action: Disinfection					Type of Remedial Action: Sedimentation				
		No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area	No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area
U. S. TOTALS—SURVEYED											
0-500	2	0	0	$ 0	$ 0	0.00	0	0	$ 0	$ 0	0.00
501-1,000	12	0	300	1,610,000	5,367	0.08	1	0	0	0	0.00
1,001-5,000	124	3	700	0	0	0.01	4	760	0	0	0.01
5,001-10,000	97	0	0	0	0	0.00	1	0	0	0	0.00
10,001-25,000	98	4	100	25,000	250	0.00	3	101	60,000	594	0.00
25,001-50,000	120	3	0	0	0	0.00	4	3,630	0	0	0.01
50,001-100,000	91	8	7,140	0	0	0.02	6	7,190	0	0	0.02
100,001-500,000	69	1	0	0	0	0.00	2	1,800	570,500	317	0.00
500,001 & Over	28	1	0	0	0	0.00	1	0	0	0	0.00
Total	641	20	8,240	$1,635,000	$ 198	0.00	22	13,481	$630,500	$ 47	0.01
U. S. TOTALS—PROJECTED											
0-500	50	0	0	$ 0	$ 0	0.00	0	0	$ 0	$ 0	0.00
501-1,000	111	0	2,775	14,892,500	5,367	0.08	9	0	0	0	0.00
1,001-5,000	458	11	2,585	0	0	0.01	14	2,807	0	0	0.01
5,001-10,000	228	0	0	0	0	0.00	2	0	0	0	0.00
10,001-25,000	204	8	208	52,083	250	0.00	6	210	125,000	595	0.00
25,001-50,000	120	3	0	0	0	0.00	4	3,630	0	0	0.01
50,001-100,000	91	8	7,140	0	0	0.02	6	7,190	0	0	0.02
100,001-500,000	69	1	0	0	0	0.00	2	1,800	570,500	317	0.00
500,001 & Over	28	1	0	0	0	0.00	1	0	0	0	0.00
Total	1,359	32	12,708	$14,944,583	$1,176	0.00	44	15,637	$695,500	$ 44	0.01

TABLE E-24C—SUMMARY OF REMEDIAL ACTION PROPOSED BY ENGINEERING REPORTS BY TYPE OF PROJECT; NUMBER, COST, COST-PER-ACRE, AND PERCENT OF CITY SERVED BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Type of Remedial Action: In-System Storage					Type of Remedial Action: Off-System Storage				
		No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area	No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area
		U. S. TOTALS—SURVEYED									
0-500	2	0	0	$ 0	$ 0	0.00	0	0	$ 0	$ 0	0.00
501-1,000	12	0	0	0	0	0.00	0	0	0	0	0.00
1,001-5,000	124	2	700	1,314,130	1,877	0.01	2	40	100,000	2,500	0.00
5,001-10,000	97	1	637	1,700,000	2,669	0.01	0	0	0	0	0.00
10,001-25,000	98	0	0	0	0	0.00	3	0	3,000,000	0	0.00
25,001-50,000	120	3	6,150	0	0	0.02	5	4,030	0	0	0.01
50,001-100,000	91	3	6,552	0	0	0.02	1	3,100	0	0	0.01
100,001-500,000	69	3	4	3,244,200	811,050	0.00	1	200	1,300,000	6,500	0.00
500,001 & Over	28	6	139,280	5,950,000	43	0.19	5	59,546	371,957,000	6,247	0.08
Total	641	18	153,323	$12,208,330	$ 80	0.07	17	$66,916	$376,357,000	$5,624	0.03
U. S. TOTALS—PROJECTED											
0-500	50	0	0	$ 0	$ 0	0.00	0	$ 0	$ 0	$ 0	0.00
501-1,000	111	0	0	0	0	0.00	0	0	0	0	0.00
1,001-5,000	458	7	2,585	4,853,802	1,878	0.01	7	147	369,354	2,513	0.00
5,001-10,000	228	2	1,499	4,002,083	2,670	0.01	0	0	0	0	0.00
10,001-25,000	204	0	0	0	0	0.00	6	0	6,250,000	0	0.00
25,001-50,000	120	3	6,150	0	0	0.02	5	4,030	0	0	0.01
50,001-100,000	91	3	6,552	0	0	0.02	1	3,100	0	0	0.01
100,001-500,000	69	3	4	3,244,200	811,050	0.00	1	200	1,300,000	6,500	0.00
500,001 & Over	28	6	139,280	5,950,000	43	0.19	5	59,546	371,957,000	6,247	0.08
Total	1,359	24	156,070	$18,050,085	$ 116	0.06	25	$67,023	$379,876,354	$5,668	0.02

TABLE E-24D—SUMMARY OF REMEDIAL ACTION PROPOSED BY ENGINEERING REPORTS BY TYPE OF PROJECT; NUMBER, COST, COST-PER-ACRE, AND PERCENT OF CITY SERVED BY POPULATION GROUP

		Type of Remedial Action: Chemical					Type of Remedial Action: Automated Regulator				
Pop. Group	No. of Jurisdictions	No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area	No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area
U. S. TOTALS—SURVEYED											
0-500	2	0	0	$ 0	$ 0	0.00	0	0	$ 0	$ 0	0.00
501-1,000	12	0	0	0	0	0.00	0	0	0	0	0.00
1,001-5,000	124	2	293	880,000	3,003	0.00	2	0	0	0	0.00
5,001-10,000	97	0	0	0	0	0.00	0	0	0	0	0.00
10,001-25,000	98	0	0	0	0	0.00	3	100	15,000	150	0.00
25,001-50,000	120	1	0	0	0	0.00	3	3,630	900,000	248	0.01
50,001-100,000	91	1	0	0	0	0.00	1	0	0	0	0.00
100,001-500,000	69	0	0	0	0	0.00	6	5,200	10,197,000	$1,961	0.01
500,001 & Over	28	1	0	929,000	0	0.00	1	25,000	1,750,000	70	0.03
Total	641	5	293	$1,809,000	$6,174	0.00	16	33,930	$12,862,000	379	0.01
U. S. TOTALS—PROJECTED											
0-500	50	0	0	$ 0	$ 0	0.00	0	0	$ 0	$ 0	0.00
501-1,000	111	0	0	0	0	0.00	0	0	0	0	0.00
1,001-5,000	458	7	1,082	3,250,322	3,004	0.00	7	0	0	0	0.00
5,001-10,000	228	0	0	0	0	0.00	0	0	0	0	0.00
10,001-25,000	204	0	0	0	0	0.00	6	208	31,250	150	0.00
25,001-50,000	120	1	0	0	0	0.00	3	3,630	900,000	248	0.01
50,001-100,000	91	1	0	0	0	0.00	1	0	0	0	0.00
100,001-500,000	69	0	0	0	0	0.00	6	5,200	10,197,000	1,961	0.01
500,001 & Over	28	1	0	929,000	0	0.00	1	25,000	1,750,000	70	0.03
Total	1,359	10	1,082	$4,179,322	$3,863	0.00	24	34,038	$12,878,250	$ 378	0.01

TABLE E-24E—SUMMARY OF REMEDIAL ACTION PROPOSED BY ENGINEERING REPORTS BY TYPE OF PROJECT; NUMBER, COST, COST-PER-ACRE, AND PERCENT OF CITY SERVED BY POPULATION GROUP

		Type of Remedial Action: Elimination of Illegal Connections					Type of Remedial Action: Others				
Pop. Group	No. of Jurisdictions	No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area	No. Jurisdiction With Proposed Projects	Area To Be Served (Acres)	Cost	Cost /Acre	Project Area /Total Combined Sewer Area
U. S. TOTALS—SURVEYED											
0-500	2	0	0	$ 0	$ 0	0.00	0	0	$ 0	$ 0	0.00
501-1,000	12	0	0	0	0	0.00	1	500	210,000	420	0.14
1,001-5,000	124	2	10	0	0	0.00	5	1,265	92,000	73	0.02
5,001-10,000	97	5	1,950	180,000	92	0.03	7	2,132	1,032,000	484	0.03
10,001-25,000	98	3	260	12,000	46	0.00	10	960	3,610,000	3,760	0.01
25,001-50,000	120	9	14,281	1,300,000	91	0.05	6	11,232	24,933,003	2,220	0.04
50,001-100,000	91	8	23,808	1,000,003	42	0.06	5	11,163	6,000,000	537	0.03
100,001-500,000	69	8	13,724	36,225,000	2,640	0.02	10	45,000	5,786,700	129	0.08
500,001 & Over	28	2	0	0	0	0.00	4	81,000	1,002,113,000	12,372	0.11
Total	641	37	54,033	$38,717,003	$ 717	0.02	48	153,252	$1,043,776,703	$ 6,811	0.07
U. S. TOTALS—PROJECTED											
0-500	50	0	0	$ 0	$ 0	0.00	0	0	$ 0	$ 0	0.00
501-1,000	111	0	0	0	0	0.00	9	4,625	1,942,500	420	0.14
1,001-5,000	458	7	36	0	0	0.00	18	4,672	339,806	73	0.02
5,001-10,000	228	11	4,590	423,750	92	0.03	16	5,019	2,429,500	484	0.03
10,001-25,000	204	6	541	25,000	46	0.00	20	2,000	7,520,833	3,760	0.01
25,001-50,000	120	9	14,281	1,300,000	91	0.05	6	11,232	24,933,003	2,220	0.04
50,001-100,000	91	8	23,808	1,000,003	42	0.06	5	11,163	6,000,000	537	0.03
100,001-500,000	69	8	13,724	36,225,000	2,640	0.02	10	45,000	5,786,700	129	0.08
500,001 & Over	28	2	0	0	0	0.00	4	81,000	1,002,112,992	12,372	0.11
Total	1,359	51	56,980	$38,973,753	$ 684	0.02	88	164,711	$1,051,065,334	$ 6,381	0.06

TABLE E-25A—SUMMARY OF CURRENT PLANS BY COMMUNITIES FOR REMEDIAL ACTION BY TYPE OF PROJECT, AVERAGE COST-PER-ACRE AND PERSON SERVED, AVERAGE REDUCTION IN NUMBER OF OVERFLOWS (IF APPLICABLE) AND OPINION AS TO APPLICABILITY OF CONTROL METHOD TO PARTICULAR COMMUNITY BY POPULATION GROUP

		Communities With Current Plans—Screening							Communities With Current Plans—Disinfection						
Pop. Group	No. of Jurisdictions	No. With Plans	Average Cost /Acre	Average Percent Reduction of Overflows	Yes	No	Don't Know	Average Cost /Capita	No. With Plans	Average Cost /Acre	Average Percent Reduction of Overflows	Yes	No	Don't Know	Average Cost /Capita
U. S. TOTALS—SURVEYED															
0-500	2	0	$ 0	0	0	0	1	$ 0	0	$ 0	0	0	0	1	$ 0
501-1,000	12	0	0	0	1	1	3	0	0	0	0	1	1	3	0
1,001-5,000	124	0	0	1	11	20	19	0	0	0	1	11	21	19	0
5,001-10,000	97	0	0	3	10	23	13	0	0	0	3	12	25	12	0
10,001-25,000	98	0	0	2	6	32	10	0	2	250	31	13	27	10	45
25,001-50,000	120	1	0	1	11	42	5	0	1	0	1	16	37	6	0
50,001-100,000	91	1	0	0	10	28	6	0	3	0	99	12	29	7	0
100,001-500,000	69	0	0	0	7	25	5	0	0	0	0	12	22	4	0
500,001 & Over	28	1	0	0	5	12	1	0	2	0	0	4	13	1	0
Total	641	3	$ 0	2	61	183	63	$ 0	8	$250	28	81	175	63	$18
U. S. TOTALS—PROJECTED															
0-500	50	0	$ 0	0	0	0	25	$ 0	0	$ 0	0	0	0	25	$0
501-1,000	111	0	0	0	9	9	27	0	0	0	0	9	9	27	0
1,001-5,000	458	0	0	1	40	73	70	0	0	0	1	40	77	70	0
5,001-10,000	228	0	0	4	23	54	30	0	0	0	4	28	58	28	0
10,001-25,000	204	0	0	2	12	66	20	0	4	260	32	27	56	20	46
25,001-50,000	120	1	0	1	11	42	5	0	1	0	1	16	37	6	0
50,001-100,000	91	1	0	0	10	28	6	0	3	0	99	12	29	7	0
100,001-500,000	69	0	0	0	7	25	5	0	0	0	0	12	22	4	0
500,001 & Over	28	1	0	0	5	12	1	0	2	0	0	4	13	1	0
Total	1,359	3	$ 0	2	117	309	189	$ 0	10	$260	22	148	301	188	$22

TABLE E-25B—SUMMARY OF CURRENT PLANS BY COMMUNITIES FOR REMEDIAL ACTION BY TYPE OF PROJECT, AVERAGE COST-PER-ACRE AND PERSON SERVED, AVERAGE REDUCTION IN NUMBER OF OVERFLOWS (IF APPLICABLE) AND OPINION AS TO APPLICABILITY OF CONTROL METHOD TO PARTICULAR COMMUNITY BY POPULATION GROUP

		Communities With Current Plans—Sedimentation							Communities With Current Plans—In-System Storage						
Pop. Group	No. of Jurisdictions	No. With Plans	Average Cost /Acre	Average Percent Reduction of Overflows	Yes	No	Don't Know	Average Cost /Capita	No. With Plans	Average Cost /Acre	Average Percent Reduction of Overflows	Yes	No	Don't Know	Average Cost /Capita
U. S. TOTALS—SURVEYED															
0-500	2	0	$ 0	0	0	0	1	$ 0	0	$ 0	0	0	0	1	$ 0
501-1,000	12	0	0	0	1	1	3	0	0	0	0	0	2	3	0
1,001-5,000	124	0	0	1	10	23	18	0	1	0	0	2	30	18	0
5,001-10,000	97	0	0	2	9	28	13	0	0	0	2	3	34	11	0
10,001-25,000	98	2	600	51	8	30	10	107	0	3,000	2	8	33	9	536
25,001-50,000	120	1	0	1	7	45	8	0	3	20	60	12	44	6	2
50,001-100,000	91	1	0	0	12	30	7	0	1	0	0	7	35	5	0
100,001-500,000	69	1	2,400	1	7	24	5	212	2	0	0	8	26	5	0
500,001 & Over	28	2	0	0	4	13	1	0	2	0	46	5	12	0	0
Total	641	7	$1,500	18	58	194	66	$111	9	$1,510	31	45	216	58	$112
U. S. TOTALS—PROJECTED															
0-500	50	0	$ 0	0	0	0	25	$ 0	0	$ 0	0	0	0	25	$ 0
501-1,000	111	0	0	0	9	9	27	0	0	0	0	0	18	27	0
1,001-5,000	458	0	0	1	36	84	66	0	3	0	0	7	110	66	0
5,001-10,000	228	0	0	2	21	65	30	0	0	0	2	7	80	25	0
10,001-25,000	204	4	625	53	16	62	20	112	0	3,125	2	16	68	18	558
25,001-50,000	120	1	0	1	7	45	8	0	3	20	60	12	44	6	2
50,001-100,000	91	1	0	0	12	30	7	0	1	0	0	7	35	5	0
100,001-500,000	69	1	2,400	1	7	24	5	212	2	0	0	8	26	5	0
500,001 & Over	28	2	0	0	4	13	1	0	2	0	46	5	12	0	0
Total	1,359	9	$1,217	20	112	332	189	$101	11	$2,090	23	62	393	177	$174

TABLE E-25C—SUMMARY OF CURRENT PLANS BY COMMUNITIES FOR REMEDIAL ACTION BY TYPE OF PROJECT, AVERAGE COST-PER-ACRE AND PERSON SERVED, AVERAGE REDUCTION IN NUMBER OF OVERFLOWS (IF APPLICABLE) AND OPINION AS TO APPLICABILITY OF CONTROL METHOD TO PARTICULAR COMMUNITY BY POPULATION GROUP

Pop. Group	No. of Jurisdictions	Communities With Current Plans—Off-System Storage							Communities With Current Plans—Chemical						
		No. With Plans	Average Cost /Acre	Average Percent Reduction of Overflows	Yes	No	Don't Know	Average Cost /Capita	No. With Plans	Average Cost /Acre	Average Percent Reduction of Overflows	Yes	No	Don't Know	Average Cost /Capita
U. S. TOTALS—SURVEYED															
0-500	2	0	$ 0	0	0	0	1	$ 0	0	$ 0	0	0	0	1	$ 0
501-1,000	12	0	0	0	0	2	3	0	0	0	0	0	2	3	0
1,001-5,000	124	0	0	1	8	24	17	0	0	0	0	4	27	19	0
5,001-10,000	97	1	0	2	13	24	12	0	0	2	2	4	27	17	0
10,001-25,000	98	1	3,000	2	9	29	10	536	1	0	2	5	32	11	0
25,001-50,000	120	1	0	1	20	33	7	0	0	0	0	[illegible]	44	9	0
50,001-100,000	91	0	0	0	5	38	4	0	2	0	0	4	34	6	0
100,001-500,000	69	0	0	2	10	23	5	0	0	0	0	6	26	5	0
500,001 & Over	28	3	1,910	75	7	9	1	81	1	0	0	1	14	2	0
Total	641	6	$2,273	14	72	182	60	$168	4	$ 2	2	30	206	73	$ 0
U. S. TOTALS—PROJECTED															
0-500	50	0	$ 0	0	0	0	25	$ 0	0	$ 0	0	0	0	25	$ 0
501-1,000	111	0	0	0	0	18	27	0	0	0	0	0	18	27	0
1,001-5,000	458	0	0	1	29	88	62	0	0	0	0	14	99	70	0
5,001-10,000	228	2	0	2	30	56	28	0	0	2	2	9	63	40	0
10,001-25,000	204	2	3,125	2	18	60	20	558	2	0	2	10	66	22	0
25,001-50,000	120	1	0	1	20	33	7	0	0	0	0	6	44	9	0
50,001-100,000	91	0	0	0	5	38	4	0	2	0	0	4	34	6	0
100,001-500,000	69	0	0	2	10	23	5	0	0	0	0	6	26	5	0
500,001 & Over	28	3	1,910	75	7	9	1	81	1	0	0	1	14	2	0
Total	1,359	8	$2,518	9	119	325	179	$209	5	$ 2	2	50	364	206	$ 0

TABLE E-25D—SUMMARY OF CURRENT PLANS BY COMMUNITIES FOR REMEDIAL ACTION BY TYPE OF PROJECT, AVERAGE COST-PER-ACRE AND PERSON SERVED, AVERAGE REDUCTION IN NUMBER OF OVERFLOWS (IF APPLICABLE) AND OPINION AS TO APPLICABILITY OF CONTROL METHOD TO PARTICULAR COMMUNITY BY POPULATION GROUP

		Communities With Current Plans—Automated Regulator							Communities With Current Plans—Other						
Pop. Group	No. of Jurisdictions	No. With Plans	Average Cost /Acre	Average Percent Reduction of Overflows	Yes	No	Don't Know	Average Cost /Capita	No. With Plans	Average Cost /Acre	Average Percent Reduction of Overflows	Yes	No	Don't Know	Average Cost /Capita
U. S. TOTALS—SURVEYED															
0-500	2	0	$ 0	0	0	0	1	$ 0	0	$ 0	0	0	0	1	$ 0
501-1,000	12	0	0	0	0	0	2	0	4	460	99	1	1	1	221
1,001-5,000	124	0	8,009	91	5	26	19	2,137	26	1,337	97	25	8	14	357
5,001-10,000	97	0	0	0	9	22	16	0	23	1,424	99	33	6	10	293
10,001-25,000	98	2	150	51	9	29	11	27	33	1,638	85	33	8	7	292
25,001-50,000	120	2	0	1	10	40	7	0	38	2,147	99	37	14	3	241
50,001-100,000	91	4	125	50	7	31	9	16	29	3,926	92	26	11	7	488
100,001-500,000	69	3	145	60	13	22	5	13	19	2,746	75	18	6	4	242
500,001 & Over	28	1	70	70	4	12	0	3	8	3,320	83	8	5	3	141
Total	641	12	$1,700	54	57	182	70	$ 126	180	$2,196	91	181	59	50	$162
U. S. TOTALS—PROJECTED															
0-500	50	0	$ 0	0	0	0	25	$ 0	0	$ 0	0	0	0	25	$ 0
501-1,000	111	0	0	0	0	0	18	0	37	473	102	9	9	9	227
1,001-5,000	458	0	9,860	112	18	96	70	2,632	96	1,353	98	92	29	51	361
5,001-10,000	228	0	0	0	21	51	37	0	54	1,449	104	77	14	23	298
10,001-25,000	204	4	156	53	18	60	22	28	68	1,665	86	68	16	14	297
25,001-50,000	120	2	0	1	10	40	7	0	38	2,147	99	37	14	3	241
50,001-100,000	91	4	125	50	7	31	9	16	29	3,926	92	26	11	7	488
100,001-500,000	69	3	145	60	13	22	5	13	19	2,746	75	18	6	4	242
500,001 & Over	28	1	70	70	4	12	0	3	8	3,320	83	8	5	3	141
Total	1,359	14	$3,779	66	91	312	193	$ 314	349	$1,782	94	335	104	139	$148

TABLE E-26—SUMMARY OF FINANCIAL PLANS OF COMMUNITIES BY POPULATION GROUP

Overflow Correction Plans In Capital Improvement Programs

Pop. Group	No. of Jurisdictions	Current Capital Improvement			Proposed Local Financing				
		Yes	No	Estimate In Years[1]	Pay As You Go	Assured Reserve Funds	Special User Charge	Bonds	Other
U. S. TOTALS—SURVEYED									
0-500	2	0	0	0	0	0	0	0	0
501-1,000	12	2	4	3	0	0	2	5	2
1,001-5,000	124	18	21	10	5	4	11	32	6
5,001-10,000	97	20	14	6	8	2	12	26	5
10,001-25,000	98	21	12	9	14	3	12	26	5
25,001-50,000	120	29	18	5	12	3	11	39	9
50,001-100,000	91	25	15	16	8	0	9	35	6
100,001-500,000	69	22	9	7	7	2	7	27	9
500,001 & Over	28	14	1	0	6	3	2	10	6
Total	641	151	94	9	60	17	66	200	48
U. S. TOTALS—PROJECTED									
0-500	50	0	0	0	0	0	0	0	0
501-1,000	111	18	37	3	0	0	18	46	18
1,001-5,000	458	66	77	10	18	14	40	118	22
5,001-10,000	228	47	32	7	18	4	28	61	11
10,001-25,000	204	43	25	10	29	6	25	54	10
25,001-50,000	120	29	18	5	12	3	11	39	9
50,001-100,000	91	25	15	16	8	0	9	35	6
100,001-500,000	69	22	9	7	7	2	7	27	9
500,001 & Over	28	14	1	0	6	3	2	10	6
Total	1,359	264	214	9	98	32	140	390	91

[1] If not current (5-7 years) capital improvement program, how many years until project will be started?

APPENDIX F

SELECTED STATE TOTALS

Number of jurisdictions
Population
Area
Miles of sewers
Number of overflows
Number of regulators

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TABLE F-1—NUMBER OF JURISDICTIONS SURVEYED AND POPULATION BY STATES[1] AND TYPES OF SEWER SERVICE

		POPULATION							
		Separate							
		Sanitary		Storm		Combined		Unsewered	
State	Number of Jurisdictions Surveyed	No. Rep.	Number	No. Rep.	Number	No. Rep.	Number	No. Rep.	Number
Alaska	4	4	56,695	4	34,460	4	10,020	4	560
Arkansas	2	2	83,000	2	26,000	2	30,800	2	700
California	3	4	488,000	4	488,000	4	854,000	4	58,700
Colorado	3	3	593,475	2	218,250	3	40,875	3	9,700
Connecticut	10	10	278,904	7	204,904	10	431,083	10	98,000
Delaware	5	5	15,600	5	2,400	5	93,200	5	800
District of Columbia	1	1	415,000	1	415,000	1	400,000	1	—
Florida	1	1	17,050	—	—	1	4,459	1	500
Georgia	5	5	512,881	2	31,000	5	377,773	5	63,746
Idaho	3	3	37,301	3	9,100	3	11,000	3	210
Illinois	60	60	536,020	61	482,522	60	4,796,243	63	73,522
Indiana	56	55	498,568	52	349,453	54	1,654,346	54	103,522
Iowa	15	15	374,406	13	282,660	15	276,981	15	17,900
Kansas	4	4	189,700	4	91,200	4	127,800	4	33,600
Kentucky	12	11	97,450	11	41,400	12	187,010	13	4,245
Maine	19	19	59,350	19	44,750	19	184,800	19	60,045
Maryland	5	4	903,890	4	903,890	4	11,650	5	—
Massachusetts	24	18	372,640	17	299,740	18	762,732	22	70,370
Michigan	61	60	1,160,330	60	483,048	59	2,715,566	64	90,840
Minnesota	8	9	577,000	9	523,100	8	400,650	9	6,400
Mississippi	1	1	24,400	1	22,800	1	1,600	1	—
Missouri	5	5	980,650	5	290,000	5	1,160,136	5	44,450
Montana	3	2	—	2	—	2	12,878	3	600
Nebraska	3	3	93,000	3	83,500	3	302,400	3	400
Nevada	3	3	84,500	3	76,500	3	39,500	3	—
New Hampshire	11	10	23,550	9	18,100	10	173,851	10	34,350
New Jersey	11	10	134,350	9	63,950	10	1,086,300	12	—
New York	38	36	1,233,945	34	384,608	37	8,368,049	39	233,802
North Carolina	1	1	14,000	1	14,000	1	6,000	1	—
North Dakota	10	9	75,235	9	68,070	9	37,375	9	150
Ohio	52	47	825,315	45	491,385	48	1,335,440	52	103,290
Oregon	14	14	155,645	10	89,102	14	364,736	14	78,154
Pennsylvania	65	62	1,696,716	57	1,421,541	62	2,202,547	65	54,669
Rhode Island	5	5	40,283	5	40,283	4	277,101	5	4,827
South Dakota	2	2	3,800	2	4,660	2	13,600	2	—
Tennessee	3	3	170,776	2	8,000	3	207,490	3	203,260
Texas	3	3	1,120,500	3	219,500	3	78,600	2	19,100
Vermont	12	9	12,600	10	5,000	11	69,146	11	4,247
Virginia	5	5	237,000	5	156,000	6	306,300	6	4,600
Washington	15	15	262,229	16	95,958	15	702,538	15	75,955
West Virginia	25	24	154,828	23	119,487	24	250,577	23	12,734
Wisconsin	23	21	812,477	23	684,263	21	534,330	22	6,445
Wyoming	1	1	1,075	1	1,075	1	1,700	1	25

NOTE: [1] States without Combined Sewers are not listed.

TABLE F-2—AREA AND MILES OF SEWERS BY STATE[1] AND TYPES OF SEWER SERVICE

	Area (In Acres)								Total Miles of Sewers Collector & Interceptor					
	Separate Sewers				Combined Sewers		Unsewered		Sanitary		Storm		Combined	
	Sanitary		Storm											
State	No. Rep.	No. of Acres	No. Rep.	No. of Acres	No. Rep.	No. of Acres	No. Rep.	No. of Acres	No. Rep.	No. of Mi.	No. Rep.	No. of Mi.	No. Rep.	No. of Mi.
Alaska	4	6,612	4	4,016	4	1,560	4	4,326	4	94	4	39	4	18
Arkansas	2	34,820	2	7,060	2	7,680	2	300	2	410	2	65	2	196
California	4	74,003	4	54,803	4	37,600	4	10,040	4	1,246	4	293	4	945
Colorado	3	73,655	3	26,702	3	4,825	3	3,202	3	506	3	231	3	54
Connecticut	10	29,882	8	27,382	9	40,623	9	79,859	10	547	8	349	9	540
Delaware	4	2,350	4	236	5	10,870	5	20	4	27	4	5	4	205
Dist. of Columbia	1	16,635	1	16,635	1	12,740	1	9,898	—	—	—	—	—	—
Florida	1	1,670	—	—	1	437	1	43	1	55	1	30	1	6
Georgia	5	77,502	2	7,000	5	65,195	5	15,971	3	1,744	3	150	4	751
Idaho	3	7,227	3	2,506	3	1,246	3	320	2	105	2	13	2	21
Illinois	60	98,06[illegible]	61	90,672	60	326,624	64	34,936	66	1,825	65	780	66	7,565
Indiana	55	113,0[illegible]	[illegible]4	84,660	55	216,004	55	41,906	53	1,774	53	447	53	4,492
Iowa	15	77,198	15	55,542	15	45,825	15	59,808	12	973	13	454	13	772
Kansas	4	40,888	4	13,700	4	14,490	4	20,093	4	686	4	263	4	322
Kentucky	11	16,723	11	4,966	10	21,186	10	1,391	12	272	12	71	9	297
Maine	17	23,318	17	16,613	17	40,287	15	342,992	17	133	16	80	17	573
Maryland	5	51,550	5	51,550	5	4,322	5	7,680	5	1,249	3	738	4	24
Massachusetts	19	57,397	18	52,066	20	105,823	21	133,344	22	3,467	21	912	21	2,539
Michigan	62	170,330	61	81,453	61	207,787	65	107,610	64	3,048	63	1,787	61	5,970
Minnesota	9	48,162	9	41,120	8	33,828	9	44,468	9	1,089	9	547	9	1,081
Mississippi	1	3,040	1	2,880	1	160	1	—	1	49	1	21	1	1
Missouri	5	112,365	5	26,415	5	147,660	5	146,440	5	3,825	5	1,001	4	3,487
Montana	3	585	3	60	3	1,839	3	939	2	2	3	1	2	26
Nebraska	3	10,340	3	10,050	3	26,200	3	300	2	27	3	3	2	6
Nevada	3	6,396	3	7,024	3	3,612	3	7,200	3	203	3	58	3	134
New Hampshire	9	21,097	8	23,820	9	27,683	9	126,510	10	146	10	128	11	642
New Jersey	11	10,131	11	9,533	11	32,384	12	10,419	12	249	12	191	11	988
New York	35	98,923	34	46,936	36	242,236	38	60,556	35	2,022	34	1,077	35	6,164
North Carolina	1	2,958	1	2,958	1	1,970	1	—	—	—	—	—	—	—
North Dakota	10	10,886	10	9,750	10	6,366	10	635	9	128	10	89	10	159
Ohio	47	207,498	43	171,399	46	224,842	45	63,703	41	3,167	41	1,447	42	3,704
Oregon	14	32,398	13	23,872	14	39,902	14	30,677	14	816	14	263	14	1,283
Pennsylvania	61	90,224	59	71,851	58	158,504	62	33,183	59	1,843	57	1,486	55	3,696
Rhode Island	6	2,368	6	2,338	4	18,383	6	11,579	6	94	6	92	5	485
South Dakota	2	550	2	970	2	2,540	2	—	1	5	1	17	1	61
Tennessee	3	65,460	2	500	3	17,410	3	283,530	3	806	2	23	3	432
Texas	3	197,060	3	133,060	3	4,900	2	21,900	2	4,153	2	860	1	32
Vermont	8	3,626	10	2,345	6	7,895	8	51,360	9	22	9	27	9	110
Virginia	5	29,850	5	17,700	5	33,275	5	875	3	515	3	150	4	35
Washington	15	38,290	16	13,552	15	77,918	15	46,809	16	961	16	250	16	1,947
West Virginia	14	16,704	14	9,785	11	30,585	13	4,750	15	453	17	290	15	564
Wisconsin	21	106,036	23	104,010	22	42,490	21	64,069	24	2,069	24	1,661	23	1,194
Wyoming	1	90	1	90	1	330	1	380	1	2	1	2	1	8

NOTE: [1] States without combined sewers are not listed.

TABLE F-3—NUMBER OF REGULATORS AND OVERFLOWS FROM DIFFERENT SOURCES BY STATE[1]

State	Overflows												No. Regulators In Use	
	Combined Sewer		Treatment Plant		Pumping Station Bypass				Other		Total			
					Combined		Separate							
	No.	No. Rep.	No.	No. Rep.	No.	No. Rep.	No.	No. Rep.	No.	No. Rep.	No.	No. Rep.	No.	No. Rep.
Alaska	1	1	—	—	—	—	2	1	—	—	3	1	3	4
Arkansas	1	1	2	1	2	2	—	—	6	1	11	2	3	2
California	23	1	3	1	15	2	7	2	8	2	56	4	42	4
Colorado	3	4	3	4	—	—	—	—	1	4	4	12	8	3
Connecticut	131	6	14	8	12	4	9	3	7	2	173	10	152	10
Delaware	48	5	4	4	6	4	1	1	—	—	59	5	3	5
District of Columbia	68	1	1	1	5	1	2	1	—	—	76	1	68	1
Florida	5	1	1	1	2	1	4	1	—	—	12	1	8	1
Georgia	65	4	13	4	17	3	50	4	12	1	157	5	87	5
Idaho	7	2	3	3	1	1	—	—	—	—	11	3	8	3
Illinois	912	52	66	44	57	20	49	14	18	4	1,102	71	982	71
Indiana	592	52	53	45	73	34	66	19	23	3	807	56	643	56
Iowa	123	12	13	13	19	9	24	9	3	1	182	15	167	15
Kansas	38	2	9	3	7	3	17	1	—	—	71	4	62	4
Kentucky	205	10	8	8	52	7	23	4	—	—	288	13	269	13
Maine	292	15	8	6	12	5	10	4	87	5	409	19	146	19
Maryland	18	4	2	1	4	3	1	1	—	—	25	5	22	5
Massachusetts	486	20	12	10	15	5	16	4	43	5	552	25	421	25
Michigan	470	41	25	24	30	13	24	11	23	4	572	67	538	67
Minnesota	132	7	11	5	8	3	20	2	10	2	181	9	206	9
Mississippi	0	0	1	1	—	—	—	—	3	1	4	1	1	1
Missouri	356	5	25	4	4	2	95	3	15	1	495	5	389	5
Montana	—	—	2	2	—	—	—	—	—	—	2	2	—	3
Nebraska	1	1	6	3	25	2	61	1	26	1	119	3	119	3
Nevada	13	2	3	3	—	—	—	—	—	—	16	3	14	3
New Hampshire	189	10	2	1	2	1	—	—	35	3	228	11	4	11
New Jersey	199	11	8	7	10	3	1	1	—	—	218	12	224	12
New York	1,165	36	30	21	47	14	11	5	1,404	8	2,657	40	912	40
North Carolina	—	—	—	—	1	1	6	1	—	—	7	1	—	1
North Dakota	33	8	3	3	18	7	1	1	—	—	55	10	34	10
Ohio	1,582	48	60	44	62	19	73	22	93	9	1,870	52	1,715	52
Oregon	89	8	17	14	30	6	22	8	2	2	160	14	142	14
Pennsylvania	1,128	54	35	32	48	19	14	9	156	8	1,381	66	892	66
Rhode Island	145	4	5	4	8	4	2	1	—	—	160	6	156	6
South Dakota	3	2	2	2	—	—	1	1	—	—	6	2	6	2
Tennessee	54	2	7	3	2	1	9	1	—	—	72	3	54	3
Texas	9	2	55	3	5	1	—	—	—	—	69	3	14	3
Vermont	81	12	7	5	14	4	4	1	72	3	178	12	63	12
Virginia	192	4	4	4	2	1	6	3	17	3	221	6	207	6
Washington	107	9	23	13	59	9	96	8	32	6	317	16	178	16
West Virginia	407	14	13	12	64	14	7	2	204	9	695	25	466	25
Wisconsin	506	20	23	21	21	9	21	10	3	2	573	25	551	25
Wyoming	1	1	1	1	—	—	—	—	—	—	2	1	1	

NOTE: [1] States with combined sewers are not listed.

APPENDIX G

CONTROL AND/OR TREATMENT OF COMBINED SEWER OVERFLOWS AND STORM WATER DISCHARGES

Sewer Separation

Separation of combined sewers has been carried on by such communities as Washington, D. C.,[1] Tacoma, Washington,[2] and Eugene, Oregon.[3] The City of Minneapolis has carried out a program of limited separation since the early 1930's.[4]

Included in this general category are projects which can be described as "pipe within a pipe."

Separation is generally accepted as being the most effective way of isolating storm water from sewage. Costs are extremely high and this leads to consideration of other methods.

In-System Storage

In-system storage has been utilized at Columbus, Ohio since the early 1930's.[5] The system provided plain sedimentation tanks without facilities for removing sludge during storm water flow.

A recent FWPCA grant project includes the modernization of three combined storm flow treatment tanks and includes automatic controls for regulator type sluice gates, new traveling bridge-type sludge collectors and pumps. Continuous removal from the tanks is the objective since long-term retention of sludge and subsequent discharge of sludge to the existing activated sludge plant resulted in anaerobic conditions in an aeration tank. Control of flow using automatically operated sluice gates will avoid overloading and surcharge of the sewer discharging to the treatment plant.[6]

The Johnson County, Mission Township Sewer District, Kansas, provides storage in addition to sedimentation. Scheduled sludge and scum removal is included within the design.[7]

Use of retention tanks to hold peak combined sewage flows in excess of interceptor capacity during a storm and release of stored flows to the interceptor following the storm was recently considered for Halifax, Nova Scotia.[3] Such tanks have been used in Great Britain, Europe, and Toronto, Canada in association with treatment plants which receive combined sewage.

A recent project was constructed to serve the cities of Grosse Pointe Woods and Harper Woods, Northeast of Detroit, Michigan.[9] Detention of combined sanitary wastes and storm flow for a one-year storm is 7.5 minutes. Cleaning settled sludge from the 509,000-cubic-ft. basin is by flushing with water from the public water supply system. From its initiation in July, 1960 to the fall of 1962, 4,500 cubic yards of wet sludge were removed as a result of 22 such operations.

Detroit, Michigan will maximize its in-system storage capability with new power-operated diversionary overflow structures, and automated control instrumentation.[6] At Minneapolis-St. Paul, "in-system storage" will be achieved by means of overflow control and flow rerouting procedures.

Off-System Storage

Nassau and Suffolk Counties, Long Island, New York, use hundreds of basins to capture separate storm water runoff as a source to augment the ground water supply.[10]

This is in the nature of the vast system employed by the British Crown Colony of Hong Kong where every attempt is made to capture surface runoff for use as a source of water supply.

German practice included overflows to brooks on which dams had been built to store a mixture of sewage and storm water.

Off-system storage basins were generally used to prevent hydraulic overflow at points which were a great distance from receiving streams and which therefore were not favorable for diversion sewers.

The use of upland reservoirs, debris dams and some flood control type of impoundments have been incorporated in schemes for control of storm water runoff to prevent hydraulic overload of combined sewer systems. Consideration was given to this type of solution for the Washington, D. C. metropolitan region. Off-system storage is also considered a requirement for the control of sediment. Off-system storage represents one of the simplest methods of controlling storm water runoff.[11]

The FWPCA is carrying out a feasibility study of a storage reservoir to be constructed in Lake Erie, to receive and hold combined sewer overflows.

Automated Regulators

Automated regulators are being considered in conjunction with the flow routing of combined wastes and the improvement of sewer efficiency. Automated regulators would be controlled through a system of telemetering. An alarm system would notify maintenance staff when and where overflow occurs and for how long.

The cities of Seattle, Washington, Detroit, Michigan and Minneapolis, Minnesota, have recently received grants from the Federal Water Pollution Control Administration to conduct studies in the use of such regulators. Minneapolis will replace existing regulators with new power-operated gates at 15 key diversionary locations. Seattle, Washington will provide means for automatic selective discharge at points of storm water overflows.[6]

New York City, New York will experiment with the Ponsar Regulator—a system using a form of siphon designed to deliver a predetermined maximum volume of combined sewage to the interceptor sewer.[6]

Screening

Guntzel[12] discusses the effect of storm flow on streams and use of a screening plant to permit the discharge of greater quantities of storm water into a stream as the dilution necessary is less for screened than for unscreened storm water.

The City of Halifax, Nova Scotia uses an aerated grit tank as well as a rack of freely suspended steel rods which are intended to intercept materials that would be difficult to remove from the retention tanks.[3]

Early German practice considered use of racks and screens to retain larger solids and flotable wastes.

In New York City, the facilities planned for treatment of storm water include screening equipment to screen flow to dewatering pumps. These consisted of coarse bar screens, mechanically cleaned by cable and rake-type mechanism. Screenings would be discharged into a trough for discharge into steel screening containers.[13]

Disinfection

Excess mixtures of storm water flow and sewage are settled, skimmed, and chlorinated in the holding tanks of the Mission Township District of Johnson County, Kansas.[7]

Chlorination of storm flow was considered for Hendrix Street Canal, Fresh Creek Paardegat Basin and Spring Creek, New York City, marginal pollution control projects.

The City of New Orleans, Louisiana, has received a grant from the FWPCA to demonstrate: The effectiveness, efficiency and economics of using open drainage canals as treatment facilities; the effectiveness of chlorine and hypochlorite disinfection on intermittent high flow discharges and the optimization of various feeding rates, multiple points of application, and contact time. Facilities include a sodium hypochlorite blending plant and chlorine alarm system.[6]

Sedimentation

The holding stations in Johnson County, Mission Township District, Kansas provide a 30-minute detention at maximum design rate.[7]

The New Hampshire Water Pollution Commission requires detention by storm water tanks of no less than 15 minutes for the maximum intensity of overflow at the selected frequency to be anticipated.[14]

New York City projects for marginal pollution control are planned to include basins for treatment of storm water overflows. The basins are designed to be empty normally and facilities are provided to clean the basins after every storm. Mixed storm water and sewage retained in the basins will be discharged to the city's sewage treatment plants. Sludge and grit can be removed from the basins after they have been partially or completely dewatered.[13]

Milwaukee, Wisconsin will use intercepting devices to discharge into a detention tank.[6]

Chemical Treatment

New York City used sodium nitrate to alleviate odor conditions in the area of the 1964-65 World's Fair when combined sewage overflowed into Flushing Creek. An FWPCA grant to the Dow Chemical Company will be used to demonstrate the use of polyelectrolytes and disinfectants for the treatment of overflow wastes in the Milk River drainage district in the vicinity of Detroit, Michigan.

Partial separation and other methods have been used by Halifax, Nova Scotia. Seattle, Washington[15] also considered the use of holding tanks and partial separation to alleviate its problems. The Boston Metropolitan District Commission is scheduling construction of retention basins and chlorination facilities although early legislation recommended separation utilizing a FWPCA demonstration grant.

In New England, lagoon projects have been designed to provide treatment of all waste, both storm water and sewage.

British practice has for years included the use of holding tanks at sewage treatment plant sites to intercept and provide sedimentation for flows up to six times dry weather flow. In actual practice, this figure has been left to judgment and has been modified both on the high and low sides. Presently, the matter of combined flows is being reviewed by a committee in Great Britain.

The use of surface runoff devices, such as improved gutter and street runoff design to extend the time of concentration, has been given consideration.

The FWPCA is experimenting with a rapid flow combustible filter which uses coal as a medium for treatment of combined sewer overflows.[6] The following cities have FWPCA demonstration grants for the indicated projects.

Columbus, Ohio will upgrade its combined sewage overflow holding tanks by installing controls and automatic operated sluice gates and sludge collector mechanisms.[6]

Meridian, Idaho will experiment with shallow wells to reduce infiltration by drawing down the high ground water table caused by irrigation flows.[6]

Shelbyville, Illinois plans to use a program of limited separation. Treatment will consist of storm water holding lagoons.[6]

Chicago, Illinois is planning a program of relief sewers which will discharge to deep tunnels in a form of in-system storage.

Springfield, Illinois plans to use a stabilization pond to treat bypassed storm flow of the Cook Street pumping station.[6]

East Chicago, Indiana will treat combined sewer overflows in a detention basin which will afford aerobic and anaerobic reduction.[6]

Chippewa Falls, Wisconsin will build a storm water pumping station and storage pond, in addition to providing new sewer capacity and some facilities for separation.[6]

Installation of small diameter force main transportation lines within present combined sewer lines to carry macerated sewage to interceptor lines and then to treatment is under study by a task force of the American Society of Civil Engineers with an FWPCA Demonstration Grant.[6]

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APPENDIX H

COMBINED SEWERS IN METROPOLITAN SERVICE

The most common characteristic of waste disposal systems serving both central cities and contiguous populated areas is lack of a common characteristic. There is dissimilarity as to form and administration, one from another. Just as the internal conduits of the older cities evolved largely through expediency, the linking of these with other outlying networks to form metropolitan systems has been prompted by necessity, either sanitary, economic, or both. While many are only now coming into being as growth pressures intensify, these are by no means exclusively recent developments in the pollution control field. The Boston Main Drainage System serving part of the city and some adjoining communities was designed and construction was well underway in the 1876-1884 period.

As the cities have grown outward from their respective centers, nearby outlying lands have provided the sites for politically independent communities. These range from purely residential subdivisions, to cities, to industrial complexes. In most regions these separately governed entities have coalesced until their boundaries are barely recognizable.

Within these suburban concentrations, waste water collection systems of some form have usually developed and waste disposal from these has frequently been provided initially by package plants advocated as "expendable," before areas are taken into central systems or by other independent means, such as by small plants or simply through discharge, untreated, into nearby waters. The acceptability of either of these methods has diminished as land use densities have increased. The most attractive alternative has been the transfer of the local disposal problem to the system which provides similar service for the nearby city.

In many instances the initial connections from outside areas have been made to already available portions of the core city's lines. The outside wastes thus introduced have not only admixed with those generated within the city but, depending on local circumstances, may have flowed through the full length of the receiving system. Where combined sewers have been so employed the augmented, dry weather flows have automatically reduced the dry-weather/wet-weather ratio. More frequent and longer overflows during times of rain have been the certain consequence of such encroachment, no matter how generous the initial design assumptions may have been. The temporary employment of one of the Washington, D. C., combined interceptors for service to outlying users had this predictable result.[1]

Since suburban flows may constitute but a small portion of the total loadings, their influence in increasing the quantities of wet-weather spillage may not be readily discernible. Even so, their effect cannot be ignored. Notwithstanding this, if their accommodation has eliminated an objectionable condition near or beyond the city, an overall improvement may have been realized.

Where the fringe area's collectors are of the combined type, more pronounced overflow effects in the receiving system are to be expected unless storm flows are diverted beforehand near their sources. Protect-

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ing the interceptors from excessive storm loading should be the general practice.

For example, the City of Cincinnati's interceptors receive the flows from 28 communities and one county (Hamilton) through some 250 connections using a variety of overflow-control methods.[2]

The Metropolitan Sanitary District of Greater Chicago and the City of Chicago have 400 sewers equipped with storm-overflow devices which are connected to the District interceptors.[3]

In addition, the City of Chicago's own combined sewer system is relieved at numerous points before its connection to the District facilities. The relief so provided, however, does not reduce the interceptor loads sufficiently to insure treatment of all flows reaching the vicinity of the plants. Additional and substantial diversions of storm water sewage mixtures are necessary when it rains.[4]

The recognition of the unsuitability of old combined sewer systems for the provision of service to peripheral developments has prompted the construction of major trunks having capacities intended for their use. The substantial network of interceptors constructed by the Metropolitan Commission of Milwaukee provides an illustration of this approach.

Ideally, "express" lines from the treatment plant to the city's boundaries to receive separate sanitary system wastes generated beyond may relieve the combined interceptors of the city and restore the status quo. This is being done in the Washington Metropolitan Area.[5]

If wastes produced in the developing fringe area reached the natural waters with little or no treatment prior to sewer hook-up with the city's combined interceptors, overall pollution reduction could be substantial after such connection was made if the interceptors have ample dry-weather capacity and if treatment is provided. This would be true in spite of worsening overflows during rains either in proximity to the points of local connection or farther along the interceptor. Any such apparent benefit would, of course, be reduced or could be reversed if the presence of outside flows caused greater volumes of strong and objectionable industrial wastes already being handled by the city's combined system to escape during wet weather.

Historically, the cities have not been in position to accept and dispose of suburban wastes without substantial stress on, and overtaxing of, their resources, both physical and financial. This has dictated the creation of new sewer service organizations in many instances. Where such have not developed, either annexation (if state laws are favorable) by the city or the working out of arrangements with the outside political entities to finance the city's extra costs have been necessary. Kansas City, Missouri has simply enveloped a substantial part of its surroundings, having increased its area from 82 square miles in 1957 to 312 square miles some seven years later.

The Cleveland sewer system serves some 32 outside governmental units, in whole or in part, without any form of metropolitan organization. Agreements between the city and the outside political subdivisions suffice to insure the service on the one hand and maintain the financial integrity of the city on the other.[6]

Similar arrangements are employed by a number of other cities including, but not limited to, Toledo, Philadelphia, Detroit, Cincinnati and Washington.

Under these contractual arrangements the responsibility for local sewer service to residents of the outside communities remains with the local administration be it town, county, or sanitary district. In general, the connection between any locality and the city interceptor is likewise part of the local system. Flows delivered through the connection are accepted, transported, and disposed.

Special organizations for the financing, building and operation of facilities providing services of metropolitan scope have been widely employed. Each has been designed to serve the needs peculiar to its region.

The Metropolitan Sewerage Commission of Boston was created in 1889 as an agency of the state. Through its North and South Metropolitan Districts, it has built and operated systems of interceptors serving parts of the central city as well as many surrounding communities. Additionally, the earlier Boston Main Drainage System serves the other portions of Boston and was initially designed to serve certain separate nearby towns, all as a municipal function. Both the city and the Commission have disposed of the wastes collected.

Regional service at Milwaukee is also provided by dual agencies. Here the city has its own sewer system and treatment plant under the administration of its Sewerage Commission. Milwaukee County, containing many cities and villages, is served by the separate Metropolitan Sewerage Commission which delivers all sewage collected by it to the City of Milwaukee's plant for treatment.

In its most common form, the metropolitan organization extends interceptors to take both the flow collected by the central city and the surrounding communities, and builds and operates the treatment facilities. The largest and oldest such is the Metropolitan Sanitary District of Greater Chicago, created in 1889. In addition to the City of Chicago, the District serves over 100 cities and towns in Cook County.

Most recent major metropolitan agencies are located at Seattle, and Pittsburgh in Allegheny County.

The most comprehensive organization of this nature is at St. Louis, Missouri which will not only intercept and treat all wastes from both the City and County of St. Louis, but has responsibility also for all collection systems in these jurisdictions.[7]

The central city is not necessarily involved in service to outlying communities. The latter, through special organizations have independently met their own needs in many localities. The East Bay Municipal Utility District—Special District No. 1 has constructed and operates interceptors and treatment works while its constituent cities, such as Berkeley and Oakland among others, handle their internal sewer systems. The Rahway Valley N. J. Sewerage Authority facilitates the joint sewerage operations of nine member municipalities. The Los Angeles County Sanitation Districts consist of some 19 separate districts embracing about 60 incorporated cities that make common use of treatment plant facilities.

The financing of works intended for metropolitan service has taken various forms, all intended to distribute the costs in some equitable fashion among the beneficiaries. In Boston, Chicago and Milwaukee, for example, the costs of major works are apportioned on the basis of the assessed values of the property and result in an ad valorem tax. More generally, the capital costs are included in service charges which are based on water consumption or some other fee arrangement. At Washington D. C., the outside sanitary district, counties and towns individually contracting with the city agree to pay their proportionate shares of the cost of any new facility on the basis of the capacity provided therein for their service. Such payments may be made to the city upon completion of the project or may be made in installments over a 10-year period.

The costs of operation and maintenance of facilities in metropolitan services are most commonly met through service charges based on customer's water use. Billing for this may be on a direct individual basis with the city billing each customer inside and outside the city as in Cleveland. More frequently, the charges are made to the respective outside municipalities or other political entities on the basis of water consumption or volume and character of contributed sewage flow. The methods used for meeting these charges remain the responsibility of the local authorities.

Notable exceptions to the service charge for the support of operations are the practices of the Boston and Chicago metropolitan agencies. In the former, such costs have been allocated to the communities served as a tax based on their respective populations, and are functioning on the basis of capacity connected to the system. In Chicago, all operations are simply reflected as a tax on property.

In some localities the charges for service are predicted on the quantities of sewage handled. This could serve as an incentive to some communities to initiate sewer separation projects or to reduce combined sewer flows by other means.

Charges for city costs for operating and maintaining facilities used for service to communities outside Washington are predicated on the summation of continuous gauge measurements of the sewage contributed by each. The exact costs attributable to each segment of the system are apportioned to each served jurisdiction, including the central city, in exact proportion to the service provided.

The conditions of service are as varied as the methods of financing. Among the older cities, where combined sewers were in general use in the suburbs as well as in the congested core area, flows from combined systems are accepted into the metropolitan facilities. There has, however, been a progressive discouragement of the extension of such combined systems. It is safe to assume that with few exceptions, future outside community expansion will exclude this form of collection. In some contracts or regulations covering suburban service "unlawful" storm drainage is prohibited. Obviously some forms of "lawful" storm drainage must be admissible. In Washington, D. C. the central city has prohibited the entry of surface water and ground water to the local sanitary systems by insistence on stringent plumbing regulations and low infiltration rates in the local public sewers.

Industrial wastes conveyed through community sewers to metropolitan systems are generally subject to control through regulation. The harmful, objectionable or difficult-to-treat constituents are ordinarily prohibited or restricted. Their removal or reduction by the contributing industry is a normal requirement. Wastes having strength greater than variously set limits are allowed in many instances, but extra charges based on the excess strength are applied.

There is no uniform practice as to the extension of interceptors. Cities have not built them beyond their boundaries as a normal practice, but agencies of metropolitan scope have generally penetrated the regions sufficiently to provide the service sought. The Chicago Sanitary District, for example, has a substantial program of extensions designed to keep up with and anticipate regional growth. The cost of these will be reflected in the tax levied against all property in the service area. Under the Allegheny Sanitary Authority, Pennsylvania, the interceptors were constructed for the use of 70 participating municipalities. Those subsequently wishing to enter the system are required separately to finance interceptor extensions necessary for their use.

It is apparent from these examples that the organizational, financial and regulatory practices in the nation's metropolitan areas vary within wide limits. Their variety is perhaps the strongest evidence of the legislative, administrative and engineering ingenuity which has been brought to bear in the solution of this most pressing regional problem.

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APPENDIX I

SPECIAL STUDY:
ECONOMIC IMPACT ON LAND VALUES AT COMBINED SEWER OVERFLOW LOCATIONS

The cost of correcting the problems associated with combined sewers and overflows in the country has a measurable counter-impact in the improved land usage resulting from the elimination of overflows and their effect on land and water values at such overflow locations.

This impact on land use and values is particularly pertinent when related to the increasing demand for urban land and the escalating values of such lands.

In order to bring into proper focus the national economic benefits which may result from corrections of the combined sewer problem, the survey included a special study of several selected communities in the country where responsible planning and assessing officials were asked to analyze this phase of the problem and to supply qualitative and quantitative information regarding land values where remedies to the combined sewer problem had been undertaken or were being contemplated.

General Findings

In large metropolitan areas where combined sewer overflows are obviously more numerous and where land values are greater than in smaller communities, it was found that the planning problem and the land-value differential resulting from the presence of overflow points could be ameliorated by good engineering and by the rising demand for land of any type, size or at any location. These factors are:

1. Land demand is so great that existence of overflow points at any location generally result in a noticeable depreciation of market or use value of land
2. Good engineering practices can diminish actual and apparent depreciating effects by the placement of such overflows either in public lands or at points and places in private lands where a minimum of adverse effects will result
3. Negative influences of such locations in the form of odors, unsightliness and other nuisance conditions may be corrected by planned improvements such as sewer separation projects or alternate correction measures.

Specific Findings

Several cities reported specific adverse effects in land valuation and use resulting from such overflows. These offer an indication of the magnitude of the problem. The following is one example:

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City	Location of Overflows	Land Acres Affected	Attributable Value Loss
Madison Heights, Michigan	Red Run Drain	(a) Drainage Land—100	$ 600,900
		(b) Adjacent Area Land—1,333	4,476,000
Estimated net economic benefits resulting from a removal of overflows at this location			$5,076,900

Planning statements confirm that such overflow locations have affected urban planning and land usage and that without these overflows and their depreciating effects "development would have been of a higher dollar value." The local city tax loss resulting from lack of development at Madison Heights, Michigan was estimated at $70,000 annually. Attached is an Outline of the Planner/Assessor Report on the Madison Heights situation.

Other jurisdictions where extreme demands for urban land were not reported offered similar measurable losses due to combined sewer overflows.

OUTLINE OF PLANNER/ASSESSOR REPORT

Date: Sept. 11, 1967

City: Madison Heights State: Michigan County: Oakland

Address or location of overflow point: Red Run Drain—Twelve Mile—Stephenson & eastward

1. Present land usage: Wier Structure and ROW for 1—75 (of land at overflow point—R.R. R/W, open field, commercial bldg., vacant lot, etc.)
   Zoning: Industrial
2. Adjacent land usage: Commercial and Trailer Park
   Zoning: Business and Mobile Homes
3. Area land usage: Residential = 61 acres. Industrial = 31 acres. Business = 8 acres.
   Zoning: Varies—Business, Industrial and Residential.
4. What most likely would be the use of this land if overflow were not constructed here? As presently zoned and to the quantity stated in #3 above?
5. a. Estimated improved value to *land* with no overflow (or with removal of overflow):

Residential improved value = $ 4,700/acre x Residential = 61 acres	$ 286,700
Industrial improved value = 8,200/acre x Industrial = 31 acres	254,200
Business improved value = 15,000/acre x Commercial = 8 acres	120,000
	$ 660,900

b. Estimated improved value of *adjacent land* with no overflow:
Residential improved value
= $ 3,200/acre x Residential = 800 acres $2,560,000
Industrial improved value
= 8,000/acre x Industrial = 400 acres 320,000
Business improved value
= 12,000/acre x Business = 133 acres 1,596,000
$4,476,000

c. Estimated improved value of *area lands* with no overflow:
Same as 5b.

Note: For (c) a normal influence area should be considered.
(a), (b), and (c) should include the total influence area.

d. Estimated land net economic impact resulting from a removal of this overflow:
Adding "a" and "b" above = $5,076,000.

Comments: Such overflows in our community are generally felt to adversely affect planning, inasmuch as development would have been of a higher dollar value at these locations without such overflows.

The quality and intensity of the development would have been higher. Since 1950 the area has been considered as industrial, thus the pattern of growth may or may not have been different. Pressure for residential usage has existed during the past few years and there are strong indications that, had the depreciating influence of these overflows not been present, more lands in the general area would have become residential in usage.

Signed s/Robert W. Stevens
Assessor

s/Tod J. Kilroy
Planner

SUMMARY STATEMENT

Prior to the widening and deepening of the existing Red Run Drain, a meandering creek was located in the area. The main purpose of the improvement was to construct a channel to accommodate storm water runoff and carry it to the Clinton River. At times when significant rains occur above the design capacity of the control device which diverts sanitary sewage to the Detroit system, untreated sewage is sent directly into the drainage channel. During or for one to two days following a storm, pollution is present but it is not significantly noticeable as there is adequate dilution to accommodate the majority of pollutants. Three to four days following a storm the major flows cease and the contaminated water begins to pond in low areas of the channel. From this time until the next rain these ponding areas serve as a breeding place for mosquitos and various types of rodents. The pollution situation is an extremely serious one, and has continued even with the improvement of the channel by the U. S. Army Corps of Engineers.

There is little doubt in our minds that the pollution of this drain has contributed significantly to the underdevelopment of the area immediately adjacent to the facility. Land values have suffered to the extent of more than $5 million of potential value. This loss represents an annual tax loss of approximately $70,000 in City taxes alone. This amount does not include school, county, or community college tax.

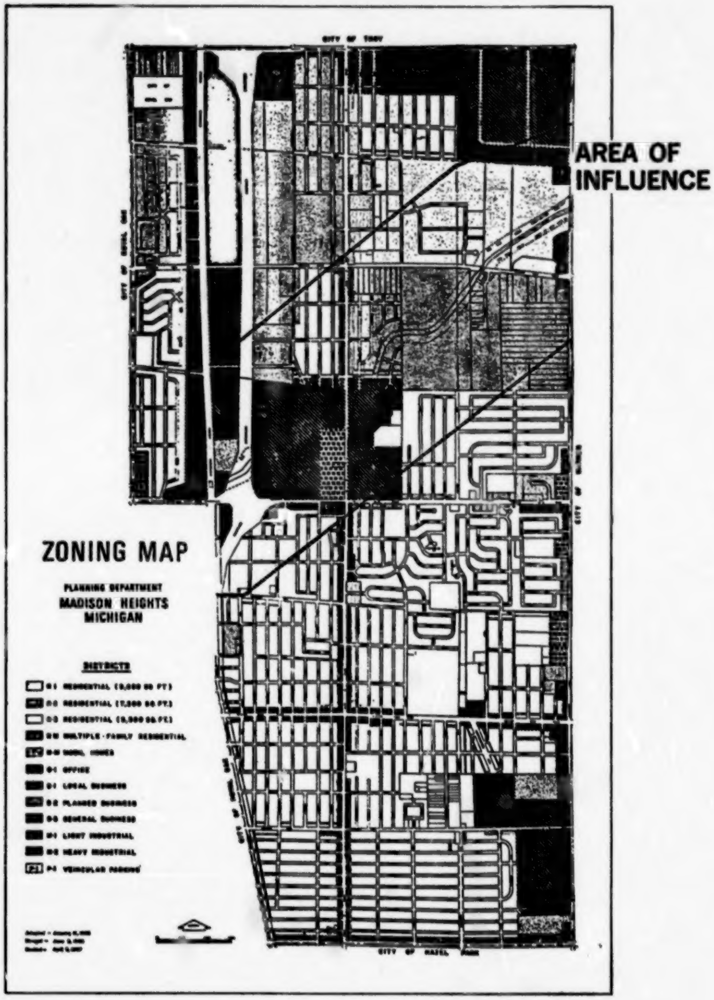
The most permanent solution to this entire Red Run Drain problem would entail removal of all sanitary sewer lines now outletting into the drain during normal and peak storm situations (i.e. completely separate storm and sanitary systems) and the complete enclosure of the drain from the weir structure at Stephenson Highway and Twelve Mile Road to the intersection of the drain and Dequindre Road. Such a program would involve Federal, State, County, and local resources in a suitable combination to adequately design, construct, and maintain such a project for our existing residents, and those residents of the future.

It is our firm conviction that several subdivisions that were constructed in areas to the north and east of Madison Heights would have located here if the Red Run Drain were not located in our City. As the metropolitan area continues to grow and develop there is little question that Madison Heights will reach its saturation point. If we are to realize our full potential as an emerging suburban community, the pollution and enclosure problem along the Red Run Drain is going to have to be dealt with. As this is the responsibility of the U. S. Army Corps of Engineers we look to the Federal Government for assistance in overcoming this situation.

Respectfully submitted,

CITY OF MADISON HEIGHTS
Tod J. Kilroy, Assoc. AIP
Planning Director

9/11/67
Robert Stevens, City Assessor C.A.E.


CITY OF TROY
AREA OF INFLUENCE
CITY OF ROYAL OAK
ZONING MAP
PLANNING DEPARTMENT
MADISON HEIGHTS
MICHIGAN
DISTRICTS
R-1 RESIDENTIAL
R-2 RESIDENTIAL (7,200 SQ. FT.)
R-3 RESIDENTIAL (5,000 SQ. FT.)
R-M MULTIPLE-FAMILY RESIDENTIAL
MOBIL HOMES
O-1 OFFICE
B-1 LOCAL BUSINESS
B-2 PLANNED BUSINESS
B-3 GENERAL BUSINESS
M-1 LIGHT INDUSTRIAL
M-2 HEAVY INDUSTRIAL
P-1 VEHICULAR PARKING
CITY OF HAZEL PARK

APPENDIX J

SUPPLEMENTAL INFORMATION REGARDING LAND USE. HIGHEST WATER USE AND NATURE OF RECEIVING WATERS IN THE VICINITY OF OVERFLOWS FROM COMBINED SEWERS AND OTHER SOURCES.

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TABLE J-1—NUMBER OF COMBINED SEWER OVERFLOWS IN THE VICINITY OF DIFFERENT TYPES OF LAND USE BY DRAINAGE BASIN

Basin No.	Agriculture	Recreation	Residential	Industrial	Vacant	Commercial	Other (Not Otherwise Identified)	Total
1	43	865	1,417	652	135	533	10	3,655
2	1	142	125	253	145	142	3	811
3	—	5	11	38	5	17	—	76
4	—	—	—	—	19	—	—	19
5	55	151	452	942	322	95	120	2,137
6	40	33	397	389	8	58	42	967
7	45	41	252	692	91	224	6	1,351
8	13	205	375	259	44	187	10	1,093
9	6	7	173	114	22	8	—	330
10	—	—	—	4	2	3	—	9
11	—	—	—	—	2	—	—	2
12	—	—	—	7	—	2	—	9
13	3	16	52	75	6	34	5	191
14	—	8	—	29	—	—	—	37
15	1	—	7	—	5	—	—	13
16	—	1	—	—	—	—	—	1
Total	207	1,474	3,261	3,454	806	1,303	196	10,701
% of Total	1.9	13.9	30.4	32.4	7.5	12.2	1.8	100
No. of Reporting Jurisdictions	67	111	221	189	125	127	19	859

TABLE J-2—NUMBER OF DISCHARGES FROM SEWAGE TREATMENT PLANT BYPASSES IN THE VICINITY OF DIFFERENT TYPES OF LAND BY DRAINAGE BASIN

Basin No.	Agriculture	Recreation	Residential	Industrial	Vacant	Commercial	Other (Not Otherwise Identified)	Total
1	9	9	10	23	12	9	3	75
2	3	2	6	10	6	2	2	31
3	—	—	2	3	1	4	—	10
4	1	—	—	—	2	—	—	3
5	24	2	11	30	54	2	5	128
6	14	3	6	8	7	1	—	39
7	21	7	12	26	14	1	11	92
8	3	9	3	23	12	2	2	54
9	13	—	15	76	12	3	—	119
10	1	—	1	1	—	—	—	3
11	—	—	—	—	2	—	—	2
12	1	—	—	—	—	—	1	2
13	4	2	9	13	13	4	1	46
14	—	3	—	5	—	—	—	8
15	3	—	—	—	—	—	—	3
16	—	—	—	—	—	—	—	—
Total	97	37	75	218	135	28	25	615
% of Total	15.8	6.1	12.2	35.4	22.0	4.5	4.1	100
No. of Reporting Jurisdictions	80	29	43	123	99	18	15	405

TABLE J-3—DISCHARGES OF PUMPING STATION BYPASSES IN THE VICINITY OF DIFFERENT TYPES OF LAND USE BY DRAINAGE BASIN

Basin No.	Agri-culture	Recrea-tion	Resi-dential	Indus-trial	Vacant	Com-mercial	Other (Not Otherwise Identified)	Total
1	9	20	36	42	22	15	—	144
2	7	5	16	10	7	11	1	57
3	3	1	40	17	9	4	1	75
4	—	—	—	—	—	—	—	—
5	25	17	92	109	97	15	2	357
6	2	5	44	12	9	3		75
7	32	29	55	36	19	6	12	189
8	7	10	26	26	26	11	22	128
9	66	3	74	12	41	—	—	196
10	—	—	—	1	—	—	1	2
11	—	—	—	—	—	—	—	—
12	—	—	—	—	—	4	1	5
13	1	13	26	21	9	13	—	83
14	—	1	1	4	—	—	—	6
15	—	—	—	—	—	—	—	—
16	—	—	—	—	2	—	—	2
Total	152	104	410	290	241	82	40	1,319
% of Total	11.6	7.9	31.2	22.0	18.4	6.2	3.2	100
No. of Reporting Jurisdictions	44	50	113	102	71	43	10	433

TABLE J-4—NUMBER OF OVERFLOWS FROM NOT OTHERWISE IDENTIFIED SOURCES IN THE VICINITY OF DIFFERENT TYPES OF LAND USE BY DRAINAGE BASIN

Basin No.	Agri-culture	Recrea-tion	Resi-dential	Indus-trial	Vacant	Com-mercial	Other (Not Otherwise Identified)	Total
1	4	116	77	127	4	25	11	364
2	—	—	—	4	—	—	—	4
3	—	—	7	4	—	7	—	18
4	—	—	—	—	1	—	—	1
5	7	6	408	17	64	236	67	805
6	—	1	15	12	1		—	29
7	—	—	2	—		—	—	2
8	—	—	—	2	8	—	—	10
9	26	—	15	7	17	—	—	65
10	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—
13	1	—	12	—	—	7	—	20
14	—	1	—	2	—	—	—	3
15	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—
Total	38	124	536	175	95	275	78	1,321
% of Total	2.9	9.4	40.5	13.2	7.2	20.8	5.9	100
No. of Reporting Jurisdictions	7	6	25	22	12	11	7	90

TABLE J-5—NUMBER OF COMBINED SEWER AND OTHER OVERFLOWS/1,000 MILES OF COMBINED SEWER BY DIFFERENT TYPES OF LAND USE BY DRAINAGE BASIN

Basin No.	Agriculture	Recreation	Residential	Industrial	Vacant	Commercial	Not Otherwise Identified	Total
1	3.9	80.9	123.1	64.1	11.5	46.0	1.7	331
2	0.4	49.8	43.8	90.2	50.9	49.8	1.1	286
3	—	5.3	19.2	44.7	5.3	25.6	—	100
4	—	—	—	—	333.3	—	—	333
5	6.9	17.5	95.8	106.9	43.0	36.9	20.8	328
6	23.0	19.5	236.9	230.5	5.2	33.3	24.1	572
7	4.4	4.0	24.8	67.5	8.9	21.8	0.6	132
8	1.4	22.4	41.1	28.6	5.7	20.5	1.1	121
9	7.8	1.7	46.0	29.6	9.6	2.0	—	97
10	—	—	—	19.0	9.5	14.3	—	43
11	—	—	—	—	40.0	—	—	40
12	—	—	—	175.0	—	50.0	—	225
13	1.2	4.8	19.2	22.5	1.8	12.3	1.5	63
14	—	8.9	—	30.7	—	—	—	40
15	7.1	—	50.0	—	35.8	—	—	93
16	—	50.0	—	—	—	—	—	50
Average	4.5	29.0	69.0	66.0	16.4	28.7	5.0	219

TABLE J-6—NUMBER OF COMBINED SEWER OVERFLOW POINTS BY BASIN AND PRESENT HIGHEST WATER USE

Basin No.	Potable Water	Body Contact Recreation	Limited Body Contact Recreation	Fishing	Shellfish	Ind. Cooling	Ind. Process	Agriculture or Irrigation	Open Drain (Transport of Wastes)	Not Otherwise Specified	Total
1	15	970	459	515	13	535	181	—	235	327	3,250
2	12	91	59	157	24	56	19	35	81	301	835
3	—	—	21	22	—	2	2	4	25	—	76
4	—	—	—	19	—	—	—	—	—	—	19
5	449	51	416	243	6	182	152	43	418	446	2,406
6		1	17	135	—	79	1	2	188	50	473
7	30	45	194	126	1	413	2	15	516	20	1,362
8	8	22	261	169	—	30	16	1	436	104	1,047
9	—	—	140	95	—	3	—	1	181	1	421
10	—	—	1	6	—	—	—	2	—	—	9
11	—	1	—	1	—	—	—	—	—	—	2
12	—	—	—	—	—	—	—	—	—	9	9
13	—	16	75	75	—	—	—	2	4	15	187
14	—	8	—	29	—	—	—	—	—	—	37
15	—	—	—	2	—	—	—	3	2	—	7
16	—	—	—	1	—	—	—	—	—	—	1
Total	514	1,205	1,643	1,595	44	1,300	373	108	2,086	1,273	10,141
% of Total	5.1	11.9	16.2	15.7	9.4	12.8	3.7	1.1	20.5	12.5	100
No. of Reporting Jurisdictions	31	46	108	139	5	43	29	28	103	86	618

TABLE J-7—NUMBER OF TREATMENT PLANT BYPASSES BY BASIN AND PRESENT HIGHEST WATER USE

Basin No.	Potable Water	Body Contact Recreation	Limited Body Contact Recreation	Fishing	Shellfish	Ind. Cooling	Ind. Process	Agriculture or Irrigation	Open Drains (Transport of Wastes)	Not Otherwise Specified	Total
1	2	3	7	21	—	6	7	1	12	13	72
2	—	8	5	5	1	5	2	2	2	4	34
3	2	—	5	6	—	3	—	—	—	—	16
4	—	—	—	1	—	—	—	—	—	2	3
5	14	5	22	51	1	4	3	7	76	13	196
6	—	3	4	10	—	4	1	2	17	4	45
7	5	4	11	27	—	1	1	8	21	3	81
8	1	10	14	15	—	—	2	—	3	8	53
9	—	1	12	14	—	1	1	7	10	1	47
10	—	—	2	—	—	—	—	1	—	—	3
11	—	1	—	1	—	—	—	—	—	—	2
12	—	—	—	—	—	—	—	1	—	1	2
13	1	4	10	14	1	—	—	2	—	2	34
14	—	1	—	2	—	—	—	—	—	—	3
15	1	—	—	—	—	—	—	2	—	—	3
16	—	—	—	—	—	—	—	—	—	—	—
Total	26	40	92	167	3	24	17	33	141	51	594
% of Total	4.4	6.7	15.5	28.1	0.6	4.0	2.9	5.5	23.7	8.6	100
No. of Reporting Jurisdictions	20	32	73	124	3	20	16	25	50	44	407

TABLE J-8—NUMBER OF PUMPING STATION BYPASSES BY BASIN AND PRESENT HIGHEST WATER USE

Basin No.	Potable Water	Body Contact Recreation	Limited Body Contact Recreation	Fishing	Shellfish	Ind. Cooling	Ind. Process	Agriculture or Irrigation	Open Drains (Transport of Wastes)	Not Otherwise Specified	Total
1	4	22	15	43	2	18	8	—	13	25	150
2	2	17	12	2	2	12	—	5	8	6	66
3	—	—	3	7	—	1	—	—	53	—	64
4	—	—	—	—	—	—	—	—	—	—	—
5	55	22	76	72	1	11	17	9	60	99	422
6	—	6	2	14	—	9	—	—	68	5	104
7	9	19	21	35	—	4	2	16	50	10	166
8	—	4	39	19	—	2	8	—	24	33	129
9	—	1	78	21	—	2	—	87	77	—	266
10	—	—	1	1	—	—	—	—	—	—	2
11	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	5	—	—	5
13	—	12	34	31	3	—	—	4	3	17	104
14	—	—	6	—	—	—	—	—	—	—	6
15	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	2	2
Total	70	103	287	245	8	59	35	126	356	197	1,486
% of Total	4.7	6.9	19.3	16.5	0.4	4.0	2.3	8.5	24.9	13.3	100
No. of Reporting Jurisdictions	18	29	69	83	4	21	11	15	79	44	373

TABLE J-9—NUMBER OF NOT OTHERWISE IDENTIFIED OVERFLOW POINTS BY BASIN AND PRESENT HIGHEST WATER USE

Basin No.	Potable Water	Body Contact Recreation	Limited Body Contact Recreation	Fishing	Shellfish	Ind. Cooling	Ind. Process	Agriculture or Irrigation	Open Drains (Transport of Wastes)	Not Otherwise Specified	Total
1	—	170	—	267	1	66	6	4	105	129	748
2	—	—	—	0	—	—	—	—	—	1	1
3	—	—	—	0	—	—	—	—	24	—	24
4	—	—	1	1	—	—	—	—	—	—	2
5	88	59	93	112	—	—	—	—	7	403	762
6	—	—	3	3	—	—	—	—	23	1	30
7	—	—	—	1	2	—	—	—	1	—	4
8	—	—	1	8	—	—	—	—	1	9	19
9	—	—	—	17	—	—	—	30	18	—	65
10	—	—	—	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—
13	—	—	13	3	—	—	—	—	—	5	21
14	—	—	8	—	—	—	—	—	—	—	8
15	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—	—	—	—
Total	88	229	119	412	3	66	6	34	179	548	1,684
% of Total	5.2	13.6	7.1	24.4	0.2	3.9	0.4	2.0	10.6	32.5	100
No. of Reporting Jurisdictions	4	3	11	15	2	3	2	3	16	12	71

TABLE J-10—NUMBER OF COMBINED AND OTHER OVERFLOWS/1,000 MILES OF COMBINED SEWERS BY BASIN AND PRESENT HIGHEST WATER USE

Basin No.	Potable Water	Body Contact Recreation	Limited Body Contact Recreation	Fishing	Shellfish	Ind. Cooling	Ind. Process	Agriculture or Irrigation	Open Drains (Transport of Wastes)	Not Otherwise Specified
1	1.2	94.0	37.8	64.5	1.2	49.6	15.4	0.3	28.0	37.6
2	4.2	31.9	20.7	55.0	8.4	19.6	6.7	12.3	28.4	100.6
3	—	—	22.5	23.6	—	2.1	2.1	4.3	52.4	—
4	—	—	17.2	344.8	—	—	—	—	—	—
5	59.9	12.3	56.7	39.6	0.7	20.3	16.9	4.8	47.4	94.5
6	—	0.6	11.5	79.5	—	45.5	0.6	1.2	121.7	29.4
7	2.9	4.4	18.9	12.4	0.3	40.2	0.2	1.5	50.5	2.0
8	0.9	2.4	28.7	19.4	—	3.3	1.8	0.1	47.9	12.4
9	—	—	34.3	27.4	—	0.7	—	7.6	48.7	0.2
10	—	—	4.8	28.8	—	—	—	9.6	—	0.2
11	—	20.0	—	20.0	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	257.1
13	—	4.8	26.2	23.4	—	—	—	0.6	1.2	6.0
14	—	7.9	7.9	28.7	—	—	—	—	—	—
15	—	—	—	13.8	—	—	—	20.7	13.8	—
16	—	—	—	43.5	—	—	—	—	—	—
U. S.	11.0	26.2	32.2	36.6	0.9	24.9	6.8	2.6	41.2	33.2

TABLE J-11—NUMBER OF COMBINED SEWER OVERFLOWS TO DIFFERENT TYPES OF RECEIVING WATERS BY DRAINAGE BASIN

Basin No.	Lake	Tide-water	Normally Dry Water-course	Stream With Dilution Factor of				Total
				<5	5-10	10-100	>100	
1	853	2,088	7	68	35	312	723	4,086
2	—	178	10	122	41	206	266	823
3	6	—	—	21	—	17	32	76
4	4	—	—	—	—	—	19	23
5	77	—	20	108	352	360	1,190	2,107
6	27	—	77	63	1	21	155	344
7	39	—	7	420	413	142	284	1,305
8	3	—	0	126	37	475	367	1,008
9	—	—	7	2	3	3	384	399
10	—	—	—	—	2	—	7	9
11	—	—	—	—	—	—	2	2
12	—	7	—	—	—	—	—	7
13	22	14	—	—	20	3	135	194
14	—	37	—	—	—	—	—	37
15	—	—	2	—	—	11	—	13
16	—	1	—	—	—	—	—	1
Total	1,031	2,325	130	930	904	1,550	3,564	10,434
% of Total	9.9	22.2	1.2	8.9	8.7	14.8	34.2	100
No. of Reporting Jurisdictions	36	49	20	53	47	56	234	495

TABLE J-12—NUMBER OF TREATMENT PLANT BYPASSES TO DIFFERENT TYPES OF RECEIVING WATERS BY DRAINAGE BASIN

Basin No.	Lake	Tide-water	Normally Dry Water-course	Stream With Dilution Factor of				Total
				<5	5-10	10-100	>100	
1	3	28	7	2	3	11	24	78
2	0	11	0	2	1	4	15	33
3	1	0	0	3	0	0	12	16
4	0	—	0	0	0	0	2	2
5	2	—	1	16	15	9	66	109
6	8	—	2	14	0	5	11	40
7	0	—	1	16	4	25	53	99
8	17	—	0	8	2	6	17	50
9	1	—	13	6	3	5	20	48
10	0	0	0	0	1	0	2	3
11	0	—	0	0	0	0	2	2
12	1	2	4	0	2	0	0	9
13	0	8	0	0	3	3	18	32
14	0	3	0	0	0	0	0	3
15	0	—	0	0	0	3	0	3
16	0	0	0	0	0	0	0	0
Total	33	52	28	67	34	71	242	527
% of Total	6.3	9.9	5.3	12.7	6.4	13.5	45.9	100
No. of Reporting Jurisdictions	21	37	7	39	26	56	192	378

TABLE J-13—NUMBER OF PUMPING STATION BYPASSES TO DIFFERENT TYPES OF RECEIVING WATERS BY DRAINAGE BASIN

Basin No.	Lake	Tide-water	Normally Dry Water-course	Stream With Dilution Factor of				Total
				<5	5-10	10-100	>100	
1	8	91	1	1	12	22	38	173
2	0	22	6	2	2	7	19	58
3	0	0	4	35	18	17	5	79
4	0	—	0	0	0	0	0	0
5	1	—	28	25	65	54	262	435
6	9	—	3	30	1	33	16	92
7	15	—	20	23	6	28	78	170
8	24	—	0	10	11	19	34	98
9	3	—	24	2	107	6	47	189
10	0	0	0	0	0	0	2	2
11	0	0	0	0	0	0	0	0
12	5	0	0	0	0	0	0	5
13	12	44	0	3	2	6	28	95
14	0	3	0	0	0	3	2	8
15	0	0	0	0	0	0	0	0
16	0	2	0	0	0	0	0	2
Total	77	162	86	131	224	195	531	1,406
% of Total	5.5	11.5	6.1	9.3	15.9	13.9	37.8	100
No. of Reporting Jurisdictions	17	34	26	40	34	66	138	355

TABLE J-14—NUMBER OF OTHER OVERFLOWS TO DIFFERENT TYPES OF RECEIVING WATER BY DRAINAGE BASIN

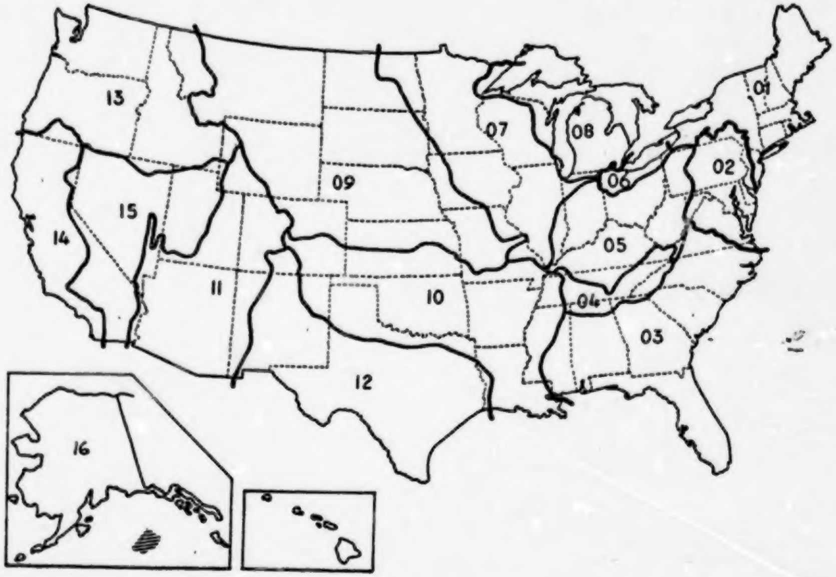
Basin No.	Lake	Tide-water	Normally Dry Water-course	Stream With Dilution Factor of				Total
				<5	5-10	10-100	>100	
1	14	351	4	1	11	76	22	479
2	—	—	—	—	—	—	—	—
3	—	12	—	—	—	—	—	12
4	—	—	—	1	—	1	1	3
5	—	—	—	—	55	3	695	753
6	2	—	—	—	—	1	5	8
7	—	—	—	2	—	10	19	31
8	8	—	—	—	—	—	4	12
9	—	—	—	—	41	—	24	65
10	—	—	—	—	—	—	—	—
11	—	—	—	—	—	—	—	—
12	—	—	—	—	—	—	—	—
13	—	17	—	—	—	4	1	22
14	—	8	—	—	—	—	—	8
15	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	—
Total	24	388	4	4	107	95	771	1,393
% of Total	1.7	27.8	.4	.4	7.7	6.8	55.1	100
No. of Reporting Jurisdictions	4	7	1	3	5	16	34	70

TABLE J-15—NUMBER OF COMBINED SEWER & OTHER OVERFLOWS/1,000 MILES OF COMBINED SEWERS TO DIFFERENT TYPES OF RECEIVING WATERS BY DRAINAGE BASIN

Basin No.	Lake	Tide-water	Normally Dry Water-course	Stream With Dilution Factor of				Total
				<5	5-10	10-100	>100	
1	71.5	283.0	0.9	5.7	3.8	32.0	61.5	458.0
2	—	62.5	3.5	42.8	14.4	72.3	93.3	289.0
3	6.4	12.8	—	22.5	—	18.2	34.2	94.0
4	—	—	—	—	—	17.2	344.8	362.0
5	0.4	—	2.2	12.1	45.4	40.5	210.1	311.0
6	45.5	—	44.4	36.3	0.6	12.7	91.2	231.0
7	2.6	—	0.7	41.0	40.7	14.8	29.6	129.0
8	5.1	—	—	14.0	4.1	52.0	40.6	116.0
9	0.7	—	1.7	0.5	10.8	0.7	100.0	114.0
10	—	—	—	—	9.6	—	33.7	43.0
11	—	—	—	—	—	—	40.0	40.0
12	—	200.0	—	—	—	—	—	200.0
13	6.7	9.3	—	—	6.0	2.1	40.8	65.0
14	—	45.0	—	—	—	—	—	45.0
15	—	—	13.8	—	—	75.9	—	90.0
16	—	44.0	—	—	—	—	—	44.0
Average	19.2	66.2	2.4	17.0	18.4	30.0	78.9	232.0

FIG. I. MAJOR RIVER BASINS OF THE UNITED STATES

01 NORTHEAST
02 NORTH ATLANTIC
03 SOUTHEAST
04 TENNESSEE RIVER
05 OHIO RIVER
06 LAKE ERIE
07 UPPER MISSISSIPPI
08 WESTERN GREAT LAKES
09 MISSOURI RIVER
10 SOUTHWEST—LOWER MISS.
11 COLORADO RIVER
12 WESTERN GULF
13 PACIFIC NORTHWEST
14 CALIFORNIA
15 GREAT BASIN
16 ALASKA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